April 15, 2002

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

In the Matter of	)	Docket No. 50-327
Tennessee Valley Authority	)	

SEQUOYAH NUCLEAR PLANT (SQN) - STEAM GENERATOR REPLACEMENT PROJECT - TOPICAL REPORT No. 24370-TR-C-002, "RIGGING AND HEAVY LOAD HANDLING"

The purpose of this submittal is to provide for your approval the nonproprietary topical report associated with rigging and heavy load handling. The topical report provides details relative to the handling of the heavy lift crane, mobile cranes, large crane components, old and replacement steam generators, reactor shield building dome and steam generator compartment roof concrete, and containment vessel dome steel sections. This topical report has been prepared in support of SQN's Unit 1 steam generator replacement project.

The enclosure to this letter contains Topical Report No. 24370-TR-C-002. The topical report provides the technical justification for the use of cranes and rigging of heavy loads over safety-related structures, systems, and components in support of the SQN Unit 1 steam generator replacement project.

As TVA presented to the NRC staff in a meeting conducted on October 10, 2001, this topical report is one of three topical reports to be provided for review in support of SQN Unit 1 steam generator replacement. The other two topical reports are Bar-Lock mechanical splices and steam generator compartment roof modification. The three topical reports will allow the steam generator replacement project to be accomplished through the 10 CFR 50.59 process and a Technical Specification (TS) change. The TS change will be associated with the rigging and heavy load handling topical report.

Please note that the proposed topical report will provide the supporting justification for a TS change to be submitted this summer. TVA requests that approval of this topical report be performed by December 2002, to support a TS change and implementation in the Spring of 2003.

This letter is being sent in accordance with NRC RIS 2001-05. Commitments are listed in Appendix A of the enclosed topical report. If you have any questions about this change, please telephone me at (423) 843-7170 or J. D. Smith at (423) 843-6672.

Sincerely,

Original signed by

Pedro Salas
Licensing and Industry Affairs Manager

Enclosure

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNIT 1
DOCKET NO. 327

TOPICAL REPORT FOR RIGGING AND HEAVY LOAD HANDLING

SEQUOYAH UNIT 1 STEAM GENERATOR REPLACEMENT

RIGGING AND HEAVY LOAD HANDLING TOPICAL REPORT

2	4/12/02	Incorporated TVA Comments	[illegible]	MRA	JVS
1	3/6/02	Incorporated TVA Comments	SWK	MRA	JVS
0	2/14/02	Issued for TVA use	SWK	DLK	JVS
REV.	DATE	REASON FOR REVISION	BY	EGS	PE
BECHTEL			JOB NO.: 24370		
			DOCUMENT NO.: 24370-TR-C-002		

SEQUOYAH UNIT 1

STEAM GENERATOR REPLACEMENT

RIGGING and HEAVY LOAD HANDLING

TOPICAL REPORT

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1.0 Abstract

In response to NRC Generic Letters 80-113 (Reference 18) and 81-07 (Reference 19), TVA established a program for the control of heavy loads at Sequoyah. This program, which addresses the guidance provided in NUREG-0612 (Reference 12), was reviewed by the NRC and incorporated into plant Procedure 0-MI-MXX-000-026.0 (Reference 8). During the upcoming Steam Generator Replacement (SGR) at Sequoyah Unit 1, which will occur during the Unit 1 Cycle 12 refueling outage, heavy loads exceeding those anticipated by Reference 8 will be handled using new safe load paths. In some cases, the load paths traverse over safety-related equipment supporting operation and safe-shutdown capability for Unit 2, which will remain in operation during the Unit 1 Steam Generator Replacement Outage (SGRO).

As defined in NRC Bulletin 96-02 (Reference 13), licensees planning to perform activities involving the handling of heavy loads over safety-related equipment while the reactor is at power and involving a potential load drop accident that has not previously been addressed in the FSAR should submit a license amendment request to the NRC. Following recent revisions to 10CFR50.59, the Bulletin's guidance was supplemented by NRC Regulatory Issue Summary 2001-03 (Reference 20), which states that, "The fact that the load is larger or is moving in a different load path than previously evaluated would enter into the risk assessment required by 10CFR50.65(a)(4) and determine under what plant conditions the load lift should occur."

This Topical Report documents the provisions made to ensure that heavy load handling activities associated with the Unit 1 SGRO can be accomplished without impacting the safe operation of Unit 2. These provisions support the risk assessment required by 10CFR50.65(a)(4) and an application for a one-time license amendment associated with the operability of the Essential Raw Cooling Water (ERCW) System. As concluded in Appendix B, these provisions and one-time license amendment do not involve a significant hazards consideration. Actions required to support the conclusions of this Topical Report are detailed in Appendix A.

2.0 Introduction

This Topical Report provides a description of and technical justification for the use of cranes and rigging of heavy loads over safety-related structures, systems, and components (SSCs) in support of the Sequoyah Unit 1 SGR. The cranes and the heavy loads addressed in this Topical Report are:

- Outside Lift System (OLS) (i.e., Mammoet PTC Heavy Lift Crane)
- Mobile (lattice boom and truck) cranes
- Large crane components
- Old and replacement steam generators
- Reactor shield building dome and steam generator compartment roof concrete sections
- Containment vessel dome steel sections

The activities addressed in this Topical Report are:

- Assembly, use, and disassembly of the OLS.
- Use of the mobile cranes for assembly/disassembly of the OLS.

- Removal of reactor shield building dome and steam generator compartment roof concrete sections and containment vessel dome steel sections.
- Removal of the old steam generators (OSGs) and installation of the replacement steam generators (RSGs).
- SSC protection from external events and postulated load drops.

The OLS is commercially designed and, therefore, is considered as non-safety related. The OLS was not specifically designed to withstand the external events addressed by 10CFR50, Appendix A, General Design Criterion (GDC) 2 that are a part of the Sequoyah design and licensing basis. However, due to the size of the OLS and because of the OLS location and proximity to the Containment, Auxiliary Building, Essential Raw Cooling Water (ERCW) piping, Refueling Water Storage Tank (RWST), Main Steam (MS) piping, and Feedwater (FW) piping, the OLS was evaluated as indicated below for those external events that might cause it to collapse when these SSCs are required to be operable.

The OLS was analyzed for both loaded and unloaded configurations for structural adequacy with design basis earthquake (DBE) loads imposed. Details of this seismic evaluation are provided in Section 5.1. As also discussed in Section 5.1, administrative controls will be imposed to restrict crane use and orientation under high winds or severe weather conditions.

This Topical Report also documents the load path provisions, equipment protection techniques, operator training, and compensatory measures that will ensure that OLS assembly/disassembly and load handling with the OLS is performed safely.

3.0 Objectives

This Topical Report provides the technical basis for a one-time Technical Specification (TS) change applicable to the Unit 1 Cycle 12 refueling outage that establishes that lifting of heavy loads will not affect ERCW system operability provided that the load movements are performed in accordance with this Topical Report and prescribed compensatory measures.

4.0 Regulatory Requirements/Criteria for Handling of Heavy Loads

Detailed below are regulatory requirements/criteria that are relevant to the handling of heavy loads over safety-related equipment. Since the load handling activities described in this topical report do not involve handling of loads over or near spent fuel, requirements related specifically to load handling over fuel are not addressed. Following each requirement/criteria is an *italicized* reference to where the requirement/criteria is addressed within this topical report.

4.1 SRP Section 9.1.5 – Overhead Heavy Load Handling Systems

Standard Review Plan (SRP) Section 9.1.5 addresses the reviews of overhead heavy loads handling systems performed by the NRC to assure conformance with the requirements of 10CFR50, Appendix A, GDC 2, 4, 5, and 61. The heavy load handling system is considered acceptable if the integrated design of the structural, mechanical, and electrical elements, the manual and automatic operating controls, the safety interlocks and devices, and the load handling instructions, inspections, maintenance and testing, provide adequate system control for the specific procedures of handling operations, if the redundancy and diversity needed to protect against malfunctions or failures are provided, and if the design conforms to the relevant requirements of the following regulations:

1) GDC 2, as related to the ability of structures, equipment, and mechanisms to withstand the effects of earthquakes. Acceptance is based in part on meeting position C.1 of Regulatory Guide 1.29 for safety-related equipment and position C.2 for non-safety related equipment, and positions C.1 and C.6 of Regulatory Guide 1.13.

   As detailed in Section 5.1, the OLS has been evaluated for seismic loads while unloaded and while loaded with its heaviest load (a steam generator). This seismic evaluation determined that the OLS will not collapse or result in a drop of the load during a seismic design basis safe shutdown earthquake event for the lift configurations to be used for the Sequoyah Unit 1 SGR.

   Per Section 5.2, use of the mobile cranes for OLS assembly/disassembly is limited to an area within 60 ft. of the OLS boom location shown on Figure 5-2. Protection (see Section 8.3) for safety-related SSCs is provided, as necessary, to ensure that Unit 1 and Unit 2 can be safely shut down and/or maintained in a safe condition in the unlikely event of a seismically induced load drop during use of these cranes for assembly/disassembly of the OLS.

2) GDC 4, as it relates to protection of safety-related equipment from the effects of internally generated missiles (i.e., dropped loads). Acceptance is based in part on meeting positions C.3 and C.5 of Regulatory Guide 1.13.

   Safety-related SSCs that may be affected by a load drop from the OLS or mobile cranes are described in Section 6. As detailed in Section 8, these SSCs have been evaluated and where necessary, protective or compensatory measures have been determined to mitigate the effects of a load drop induced SSC failure.

3) GDC 5, as related to the sharing of equipment and components important to safety, between Units 1 and 2.

   As detailed in Section 6.3, ERCW is the only shared system that could be affected by load drops from the OLS. Equipment that may be affected by a load drop is detailed in Section 8.3. As indicated in Appendix A, plant procedures will be developed to delineate specific actions required in case of a heavy load drop.

4) GDC 61, as related to the safe handling and storage of fuel.

   Conformance to this GDC is not applicable, as the load handling detailed herein will not involve moving fuel or moving loads over fuel.

Other specific criteria necessary to meet the relevant requirements of GDC 2, 4, and 61 are detailed in NUREG-0612.

4.2 NUREG-0612 – Control of Heavy Loads at Nuclear Power Plants

Section 5.1 of NUREG-0612 provides guidelines for the control of heavy loads. The objectives of these guidelines, in part, are 1) to assure that the potential for a load drop is extremely small or 2) radioactive releases resulting from damage caused by the load drop are less than 1/4 of 10CFR100 limits (i.e., less than 75 rem thyroid and 6.25 rem whole body) and to ensure that damage to equipment in redundant safe shutdown paths is not sufficient to preclude safe shutdown.

The evaluation of the radiological consequences of dropping an OSG is described in Section 7.1.

The NUREG reflects an overall philosophy that provides a defense-in-depth approach for controlling the handling of heavy loads; i.e., prevent as well as mitigate the consequences of postulated accidental drops. Part of this defense-in-depth approach involves 1) providing sufficient operator training, handling system design, load handling instructions, and equipment inspections to assure reliable operation of the handling system and 2) defining safe load paths through procedures and operator training so that to the extent practical heavy loads being carried over or near safe shutdown equipment are avoided. Where a load path that avoids safe shutdown equipment cannot be defined, alternative measures may be taken to compensate for this situation.

As detailed in Section 7, for the large equipment lifts discussed in this Topical Report, a safe load path has been chosen that minimizes potential interactions with critical equipment. For the lifts that must traverse safe shutdown equipment, compensatory measures will be implemented in the unlikely event of a load drop.

Section 5.1.1 of NUREG-0612 states that all plants should satisfy the following for handling heavy loads that could be brought in proximity to or over safe shutdown equipment:

1) Load paths should be defined for the movement of heavy loads to minimize the potential for heavy loads to impact safe shutdown equipment. These load paths should be defined in procedures, shown on equipment layout drawings, and clearly marked in the area where the load is to be handled.

   Safe load paths for the loads to be handled by the OLS have been identified as shown on Figure 5-2. Criteria for operation of mobile cranes used in the assembly/disassembly of the OLS have been developed as detailed in Section 5.2.

2) Procedures should be developed to cover load handling operations for heavy loads to be handled in proximity to safe shutdown equipment. These procedures should include identification of required equipment, inspections and acceptance criteria required before movement of the load, the steps and proper sequence to be followed in handling the load, the safe load path, and other special precautions.

   Rigging operations using the OLS and mobile cranes will be controlled and conducted by highly trained and qualified personnel in accordance with approved procedures. The entire operation has been evaluated by engineering personnel and documented by calculations, engineering drawings, and procedures. Drawings showing the safe load paths have been developed. Assembly and disassembly of the OLS will be performed in accordance with the crane manufacturer's procedures and drawings. Tornado initiated crane failures or load drops will be precluded through implementation of procedures to suspend *load handling when high winds or severe weather/tornado conditions are anticipated. As indicated in Appendix A, procedures to implement compensatory measures required to mitigate the effects on ERCW system operation of a postulated load drop will be developed and personnel will be trained in their use.*

3) Crane operators should be trained, qualified, and conduct themselves in accordance with ANSI B30.2 Chapter 2-3 guidelines.

   ANSI B30.2 is applicable to overhead gantry cranes. The appropriate guidance for the mobile cranes is ANSI B30.5. The operator training detailed in Sections 5.1 and 5.2 of this topical report conforms to the guidelines of ANSI B30.5, Chapter 5-3.

4) Special lifting devices should satisfy the guidelines of ANSI N14.6, as modified by NUREG-0612.

   The rigging operations addressed in this Topical Report do not use special lifting devices as defined by ANSI N14.6.

   As described in Section 5.1, the OLS attachments and rigging meet the requirements of ASME NQA-1-1997, Subpart 2.15 and the applicable ASME B30 series standards. The attachments and rigging used to attach the OLS to the SGs have been previously load tested in accordance ASME NQA-1, Subpart 2.15 or have a previous load history that exceeds the loads to be lifted.

5) Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9, as modified by NUREG-0612.

   As described in Section 5.1, the OLS attachments and rigging meet the requirements of ASME NQA-1-1997, Subpart 2.15 and the applicable ASME B30 series standards. This includes ANSI B30.9 as modified by NUREG-0612.

6) The crane should be inspected, tested, and maintained in accordance with ANSI B30.2, as modified by NUREG-0612.

   ANSI B30.2 is applicable to overhead gantry cranes. The appropriate guidance for the mobile cranes is ANSI B30.5. The crane inspections, testing, and maintenance detailed in Sections 5.1 and 5.2 of this topical report conform to the guidelines of ANSI B30.5, as modified by NUREG-0612.

7) The crane should be designed to meet the applicable criteria and guidelines of Chapter 2-1 of ANSI B30.2 and of CMAA-70.

   ANSI B30.2 is applicable to overhead gantry cranes. The appropriate guidance for the mobile cranes is ANSI B30.5. The manufacturer's user manual for the OLS also refers to ANSI B30.5. The crane designs detailed in Sections 5.1 and 5.2 of this topical report conform to the guidelines of ANSI B30.5, which meets the intent of ANSI B30.2 and CMAA-70.

Section 5.1.5 of NUREG-0612 states that in addition to the above requirements from Section 5.1.1, the effects of load drops should be analyzed (in accordance with the guidelines of Appendix A to NUREG-0612) and the results should indicate that damage to safe shutdown equipment is not sufficient to preclude safe shutdown.

Appendix A of NUREG-0612 states, in part, that analyses of postulated load drops should as a minimum include the following considerations:

1) The load is dropped in an orientation that causes the most severe consequences.

   The consequences of a postulated load drop from the OLS or the mobile cranes are detailed in Section 7. Where it was not possible to protect SSCs in the vicinity of the load drop, the worse case failure of these SSCs was postulated.

2) The load may be dropped at any location in the crane travel area where movement is not restricted by mechanical stops or electrical interlocks.

   As detailed in Section 7.1, loads drops along the entire load path have been postulated and evaluated. The load path is maintained by strict administrative controls. These administrative controls will be in the form of notes on drawings and procedural steps contained in controlled work packages.

3) X/Q values for determining the radiological consequences of a heavy load drop should be derived from analysis of onsite meteorological measurements based on 5% worst meteorological conditions.

   The meteorological conditions and the X/Q values used to determine the doses resulting from a postulated drop of an OSG are detailed in Section 7.1.

4) Analyses should be based on an elastic-plastic curve that represents a true stress-strain relationship.

   As detailed in Sections 7 and 8, when appropriate, the analyses are based on the true material characteristics.

5) The analysis should postulate the “maximum damage” that could result (i.e., the analysis should consider that all energy is absorbed by the structure and/or equipment that is impacted).

   Where it was not possible to analytically show that a SSC would survive the impact of a postulated load drop, the SSC was assumed to fail to the point where it could no longer perform its design function. If this failure could result in an adverse impact on other SSCs, this impact was accounted for in assessing whether compensatory measures were required to restore the affected functions.

6) Credit may not be taken for equipment to operate that may mitigate the effects of the load drop if the equipment is not required to be operable by the Technical Specifications when the load could be dropped.

   No credit has been taken for equipment not required to be operable by the Technical Specifications.

4.3 NRC Bulletin 96-02 – Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment

This bulletin requires licensees planning to handle heavy loads over safety-related equipment while the reactor is at power that involve a potential load drop accident that has not been previously evaluated in the FSAR or a change to the Technical Specifications, to submit a license amendment request in advance of the planned load movement so as to afford the NRC sufficient time for review and approval.

Since the postulated load drops could adversely affect safety-related components that are addressed in the Technical Specifications, this Topical Report has been prepared to support NRC review and approval of the change to the Technical Specifications described in Section 8.3.

4.4 NRC Regulatory Issue Summary 2001-03 – Changes, Tests, and Experiments

Attachment 1 to Regulatory Issue Summary 2001-03, Issue 7, states, "With respect to [Bulletin] 96-02, if a heavy load movement is part of a maintenance activity, there is no 10CFR50.59 evaluation needed. The fact that the load is larger or is moving in a different load path than previously evaluated would enter into the risk assessment required by 10CFR50.65(a)(4) and determine under what plant conditions the load lift should occur. If the heavy load lift is not maintenance related, and so requires a 10CFR50.59 evaluation, the licensee should follow the requirements of the revised rule to determine whether prior NRC approval is needed.

This Topical Report documents the provisions made to minimize and control the risks associated with the subject lifts. While the lifts are associated with a maintenance activity for Unit 1, it is TVA's intent that Unit 2 continues normal operation during the Unit 1 SGRO. Because of the potential interactions of the Unit 1 activities upon Unit 2 safety, and to clarify the operational issues associated with the plant Technical Specifications, a license amendment based upon this Topical Report will be requested.

5.0 Description of Cranes and Heavy Loads

The cranes described herein are commercially available equipment and are not specifically designed as single failure proof, nor are they specifically designed to withstand the external events that are a part of the plant licensing basis. Since this rigging equipment will carry large and heavy loads in the vicinity of safety-related SSCs, it must be demonstrated that the installation, use, and removal of this rigging equipment does not adversely affect the safety function of these SSCs or that alternative means of performing the SSC safety function are available.

5.1 Outside Lift System

The OLS will consist of a Mammoet Platform Twin-Ring Containerized (PTC) Heavy Lift Crane (see Figure 5-1), which is a commercially designed crane. The maximum rated load for this crane is 1763.2 tons (1600 metric tons), however this will vary with crane configuration and lift radius. The rated load for the crane configuration proposed for the Sequoyah SGR ranges from 440.8 tons (400 metric tons) to 517.9 tons (470 metric tons), depending on the lift radius. The OLS meets or exceeds ASME NQA-1 Subpart 2.15 design requirements, and its load charts and operating restrictions consider applicable dead, live, wind, impact, and out-of-plumb lift loads. The OLS, supplied with standard load charts for its various boom configurations, has a rated load capacity certified by the manufacturer and has been load tested during its production; this meets the load test requirements of ASME NQA-1, 1997 Edition, Subpart 2.15, Section 601.2. In addition, after the OLS has been erected it will be load tested by lifting a 275 ton (550 kip) test load assembly with the OLS boomed out to a radius where the test load represents 110% of the OLS rated capacity at this radius. OLS lifts of the loads described in this topical report will be performed after Unit 1 is defueled and will be completed prior to the start of refueling. The OLS load test may be performed with Units 1 and 2 in any mode (Reference 24). The OLS will be located in an area between the Service Building, the Unit 1 RWST and the Unit 1 Containment, as shown on Figure 5-2.

The OLS consists of a main A-frame boom, which is pinned to and rides on wheel trucks at its base, and has a jib boom and 2 stay beams pinned to its top end. The main boom is stabilized by a counterweight system including a backmast boom that also rides on wheel trucks. The OLS wheel trucks ride on the base ring supported by built-in outrigger support rings/plates, which enable the OLS to be self-leveling, as shown on Figure 5-3.

OLS attachments that have been specially designed for SG rigging purposes will be connected to the steam generator during Modes 5 or 6 or the defueled condition while the OSG is still within its compartment. The OLS will be attached to the SGs, Shield Building concrete sections, steel Containment vessel sections, and SG compartment concrete sections using slings, cables, spreader beams, etc. attached to the OLS load block. The OLS attachments and rigging meet the requirements of ASME NQA-1-1997, Subpart 2.15 and the applicable ASME B30 series standards. The attachments and rigging used to attach the OLS to the SGs have been previously load tested in accordance ASME NQA-1, Subpart 2.15 or have a previous load history that exceeds the loads to be lifted. Rigging will be inspected prior to use in accordance with approved procedures and rigging operations will be controlled and conducted by highly trained and qualified personnel in accordance with approved procedures.

Personnel involved in operating the OLS will receive the following instruction:

- Operators will receive the applicable Sequoyah site-specific training specified in Appendix C of MMDP-2, “Safe Practices for Overhead Handling Equipment” (Reference 9).
- Personnel will undergo hands on training with the equipment before a load is attached to the equipment.
- Prior to a lift, detailed pre-lift meetings will be conducted.
- Direction to the operators during each OLS lift will be given by technical representatives of the equipment owner and the SGR contractor rigging specialist.

During the lifting operation, the exact location of boom tip and load block will be monitored by two independent methods. Instrumentation internal to the crane provides continuous readout of crane and boom orientation and the location of the boom tip and load block. In addition, the boom tip will be continuously monitored from a remote survey station independent from the crane instrumentation. This survey station will have the necessary data input to monitor and calculate the boom tip location relative to the interfacing structures and components. The individual directing the rigging operations will be in constant communication with both the crane operator and the surveyor manning the remote survey station. These controls will be utilized to ensure that the exact location of the load is known and compliance with design requirements is maintained.

Assembly and disassembly of the OLS will be performed in accordance with the crane manufacturer's procedures and drawings and may be performed with Unit 1 and Unit 2 in Modes 1-6 or defueled. The assembly/disassembly process will require the use of mobile cranes and other equipment as detailed in 5.2. During assembly and disassembly of the OLS, the main boom will lay in an area to the north of the Unit 1 Containment as shown on Figure 5-2. The orientation of the main boom during assembly/disassembly along with the restrictions on mobile crane usage and SSC protection provisions in 5.2 ensure that Unit 1 and Unit 2 can be safely shut down and/or maintained in a safe condition in the unlikely event of a load drop during assembly/disassembly of the OLS.

The OLS has been evaluated for seismic loads while unloaded and while loaded with a steam generator (SG) as detailed in Reference 21. A SG is the heaviest load that will be handled by the OLS. This seismic evaluation determined that the OLS will not collapse or result in a drop of the load during a seismic design basis Safe Shutdown Earthquake (SSE) event for the lift configurations to be used during the Sequoyah Unit 1 SGR. Therefore, use of the crane for the Sequoyah Unit 1 SGR will not result in Seismic II/I interaction issues on the SSCs located in the vicinity of the OLS.

Reference 21 developed a GT-STRUDL 3-D lumped mass finite element model using beam/truss elements to analyze the critical lift configurations of the OLS for SSE loads. NRC Regulatory Guide (RG) 1.61 allows 7% damping for bolted steel structures for the SSE. However, this analysis conservatively used 5%, which is consistent with Table 3.7.1-1 of the UFSAR. The OLS seismic analysis was performed using the response spectrum method in both the loaded and unloaded conditions.

The seismic analysis of the OLS is based on an appropriate ground spectrum corresponding to the plant's minimum SSE design basis spectra. The OLS will be supported on a concrete ring foundation seated on a large number of battered piles anchored to bedrock. Based on soil borings the average depth of soil deposit at the location of the OLS is 30 ft. The input spectrum used for the horizontal direction is an amplified response spectrum at ground surface for an average soil depth to bedrock of 30 ft. under the crane foundation. This amplified spectra was obtained by interpolation for a 30 ft. soil deposit and reduced to correspond to the minimum design basis from Reference 27 which provides 5% damped free field top of soil response spectra curves for the Sequoyah Nuclear Plant for soil depths of 40 ft. and 20 ft. It is noted that the amplified ground spectra documented in Reference 27 are an average based on the four artificially generated time histories used to develop the more conservative "actual design spectra" (see Section 2.5.2.4 and Figure 2.5.2-14 of the UFSAR). A 10% broadened amplified SSE horizontal ground response spectrum for 5% damping for 30 ft. depth of soil corresponding to the "minimum design basis spectra" in Figure 2.5.2-14 of the UFSAR was thus developed from the 20 ft. and 40 ft. curves in Reference 27 and used as the input horizontal spectrum. Since the OLS will be supported on a concrete ring foundation seated on a large number of battered piles that are supported well into bedrock, the vertical response spectrum used for the crane seismic analysis was the minimum design basis vertical spectrum for 5% damping from Figure 2.5.2-14 of the UFSAR. The vertical response spectrum used is 2/3rds (per Section 2.5.2.4 of UFSAR) of the horizontal minimum design spectrum.

Soil springs were calculated to simulate soil-structure interaction at the foundation. The response spectra loadings were applied simultaneously in two horizontal directions and the vertical direction. Modal responses were combined using the NRC Ten-Percent Method. Co-directional responses were combined using the Square Root of the Sum of the Squares (SRSS) method.

The seismic evaluation of the OLS determined that the calculated stresses are less than the maximum allowable stresses (0.9 F_y) and the minimum safety factor against overturning is 1.1.

To further demonstrate the capability of the OLS, Reference 21 also determined the “whip-lash” effect a loss of lifted load would have on the OLS. Reference 21 determined that the whip-lash effect resulting from a postulated drop of a load from the OLS will not cause instability of the boom masts in the reverse direction, i.e. the masts will not flip over backwards and impact SSCs (e.g., Auxiliary Building, Control Building, etc.) behind the OLS.

Rigging operations will not be performed when wind speeds exceed the maximum operating wind speed for the OLS. This wind speed will be measured using an anemometer on the crane boom tip. If wind speeds increase during a rigging operation such that the wind speed may exceed the maximum operating speed, rigging operations will be suspended and the unloaded OLS will be secured by implementing administrative controls specified by the manufacturer in Reference 7. These administrative controls define the allowable mainmast and jib angles, and the slew drive and load block configurations, and are dependent on the wind speed.

To eliminate the effects of wind conditions beyond the maximum operating wind speed, a lift will not commence if analysis of weather data for the expected duration of the lift indicates the potential for wind conditions in excess of the maximum operating wind speed. Further, should there be an unexpected detrimental change in weather while the OLS is loaded, the lift will be completed and the OLS will be placed in its optimum safe configuration or the load will be grounded and the crane will be placed in a safe configuration.

Based on the above discussion, the conditions that could result in credible crane failure modes or load drops (i.e., operator errors, use of improper rigging or inappropriate slings, and crane component failures) have been minimized or eliminated through the training of rigging personnel, use of engineer developed procedures for the load lifts, performance of engineering evaluations of the OLS and rigging components, and inspection and testing of the OLS. In addition, an OLS failure or load drop due to a tornado or seismic event has been eliminated. The tornado initiated OLS failure or load drop will be eliminated through implementation of procedures to preclude load handling when high winds or severe weather/tornado conditions are anticipated. The seismic induced crane failure or load drop has been eliminated by showing that the OLS will not collapse or drop a load while loaded or unloaded during the SSE. Given the training, procedures, evaluations, inspections, and testing involved in use of the OLS, it is highly unlikely that the OLS will fail or drop a load. However, as required by NUREG-0612, load drops from the OLS have been postulated and the potential consequences of these postulated drops evaluated as detailed in Sections 7 and 8.

5.2 Mobile Cranes

Mobile (lattice boom and/or truck) cranes will be used in the assembly/disassembly of the OLS. These cranes will be used when Unit 1 and 2 in are in any operating mode or when Unit 1 is defueled. The lattice boom and truck cranes are commercially designed, ruggedly constructed, cranes with a main boom. The crane with its main boom is stabilized using a counterweight system. The design of the lattice boom and truck cranes meets ASME/ANSI Standard B30.5-2000 design requirements and their rated capacity considers applicable loadings. The lattice boom and truck cranes have been load tested during their production and will have a current certification.

Use of the mobile cranes for OLS assembly/disassembly is limited to an area within 60 ft. of the OLS boom location shown on Figure 5-2. Restrictions on the use of these cranes will also be imposed to specify the weather conditions under which they may be operated and how and when to secure the mobile cranes in case of inclement weather. These restrictions are designed to preclude adverse interactions with safety-related SSCs. Protection (see Section 8.3) for safety-related SSCs is provided, as necessary, to ensure that Unit 1 and Unit 2 can be safely shut down and/or maintained in a safe condition in the unlikely event of a load drop during use of these cranes for assembly/disassembly of the OLS.

Personnel involved in operating the mobile cranes will receive the following instruction:

- Operators will receive Sequoyah site-specific training as specified in Reference 9.
- Personnel will undergo hands on training with the equipment before a load is attached to the equipment.
- Prior to lifts over safety-related SSCs, detailed pre-lift meetings will be conducted.
- Direction to the operators will be given by technical representatives of the equipment owner, as required.

The mobile cranes will not be operated in high winds or weather conducive to tornadoes and will be relocated away from safety-related SSCs under these conditions. The mobile cranes are not designed to withstand seismic events.

Based on the above discussion, it is highly unlikely that a load will be dropped from a mobile crane. However, as required by NUREG-0612, load drops from a mobile crane has been postulated and the potential consequences of a postulated drop evaluated as described in Sections 7 and 8. None of these consequences lead to the need to invoke the one time Technical Specification change or impose the ERCW compensatory measures during lifts by the mobile cranes.

5.3 Outside Lift System Components

The OLS will arrive at the Sequoyah site in standard containers. These containers will be moved to the OLS assembly/disassembly area (see Figure 5-2) on tractor-trailers. The OLS will be assembled/disassembled in accordance with Reference 7 while both units are in Modes 1-6 or defueled. As described in Reference 7, the heaviest individual component is the lower counterweight tray at 27.8 tons (55.6 kips). The heaviest assembled component lifted during the erection process is the main mast at 135 tons (270 kips). The largest ballast blocks used are 10.9 tons (21.8 kips).

The crane components will be off-loaded from the tractor-trailers using the lattice boom and truck cranes discussed in Section 5.2, and forklifts. During the offload process, the components will be lifted slightly higher than the trailer bed and lowered to the ground. Offloading locations will be picked to minimize the potential for impacting ERCW piping. When that is not possible, timber mats (as detailed in Section 8.3) will be used to distribute the impact from a load drop such that the ERCW piping will not be affected. None of these consequences lead to the need to invoke the one time Technical Specification change or impose the ERCW compensatory measures during lifts by the mobile cranes.

5.4 Old & Replacement Steam Generators

The existing Westinghouse Model 51 OSGs will be removed and new RSGs furnished by CENP-Westinghouse will be installed. The RSGs are form, fit and function replacements of the OSGs and are similar in orientation and overall physical dimensions to the OSGs. The enveloping weight for the steam generator lifts has been determined to be 355 tons (710 kips).

Movement of the OSGs/RSGs out of/into Containment will be performed with Unit 1 in the defueled condition and Unit 2 at power. Coordination with Operations is required prior to commencement of SG movement activities.

Once lifted clear of the Containment roof, the OSGs will follow designated load paths over the top of the Containment roof as shown on Figure 5-2. Rigging and lifting of the OSGs will be performed by trained personnel, will be strictly controlled and conducted in accordance with approved procedures, and will be restricted to the load paths described herein. Once the bottom of the OSG reaches a suitable height above the ground the OLS will rotate and move the OSG to the downending area where a downending ring will be attached to the lower portion of the OSG. The OSGs will be maneuvered to a downending device designed to receive the downending ring and facilitate the downending operation. This downending device allows each OSG to be pivoted and downended directly onto its transport/storage saddles, which will be staged on the transporter. Downending equipment and the downending foundation area have been designed for the applicable loads in accordance with ASME NQA-1, Subpart 2.15. Reference 22 determined that the loads on the downending foundation are less than 150 tons (300 kips) and the soil bearing pressure from the foundation is less than the allowable pressure. Once the OSG has been set on the saddles located on the transporter, the downending ring and rigging attachments will be removed with the assistance of a construction crane. Each OSG will be handled in an identical manner (but with slightly different load paths over the Containment roof) and the RSGs will be handled in a similar manner, but reverse order using the same equipment.

5.5 Reactor Shield Building Concrete, Steam Generator Enclosure Concrete, and Containment Vessel Steel

Two holes (approximately 20 ft. by 45 ft.) will be created by cutting through the Shield Building dome and Containment vessel dome to allow removal of the OSGs and installation of the RSGs. Rigging of the Shield Building concrete and Containment vessel steel will occur only during the defueled condition. The OLS will be used to remove/replace the cut concrete and steel sections. The Containment vessel steel sections will weigh no more than 15 tons (30 kips). The Shield Building concrete sections will weigh less than 132.5 tons (265 kips).

The SG compartment roof and the Main Steam whip restraint beams below the roof will be cut and removed as one piece in each of the four compartments. The diameter of the openings is 18 to 20 feet. The cut sections of concrete from the SG compartments weigh less than 65 tons (130 kips). The OLS will be used to remove/replace the cut sections of concrete. Removal/replacement of the cut sections of concrete will take place during the defueled condition.

Movement of the above loads will be performed with Unit 1 in the defueled condition and Unit 2 at power. Coordination with Operations is required prior to commencement of heavy load movement activities.

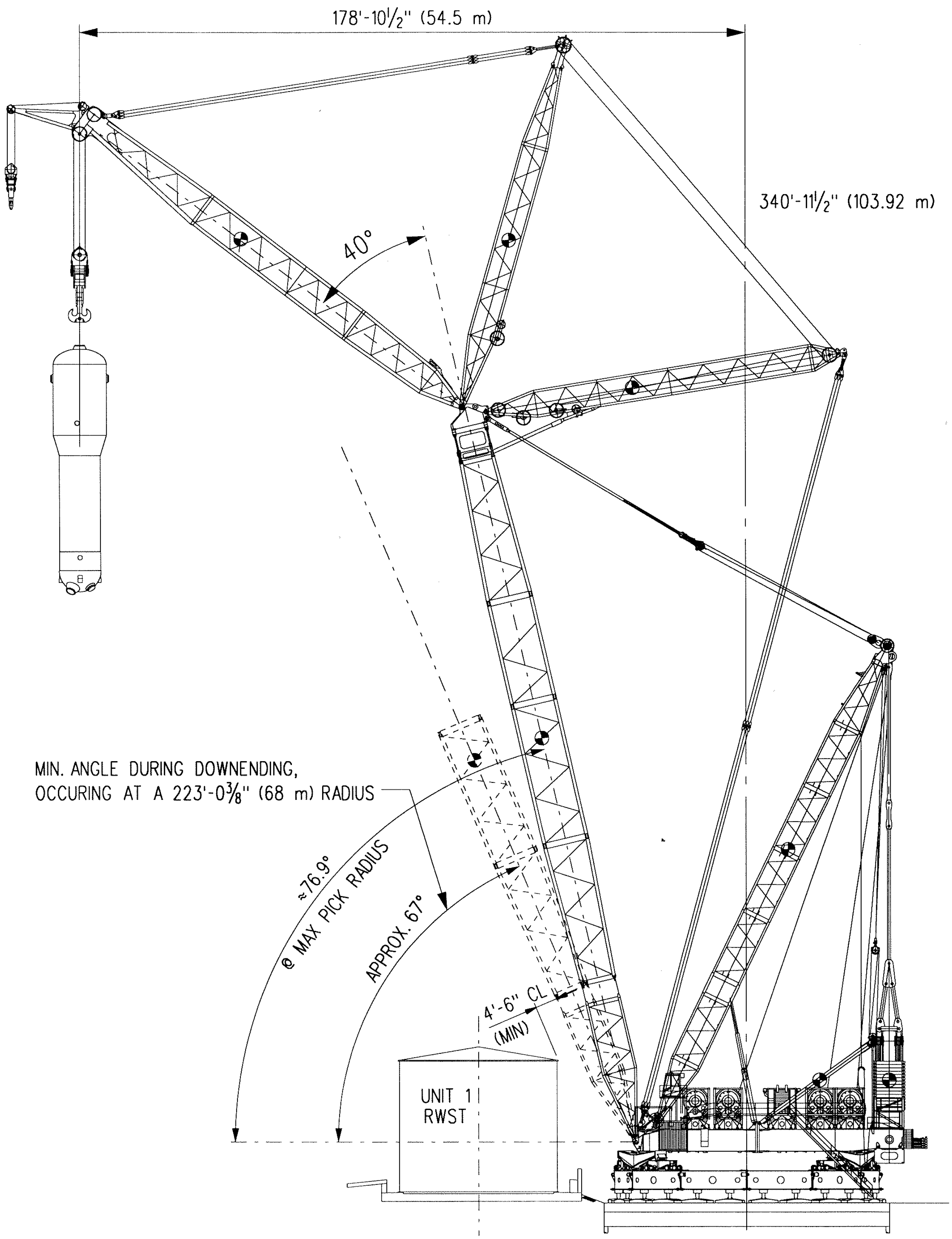

Figure 5-1 – Outside Lift System Elevation

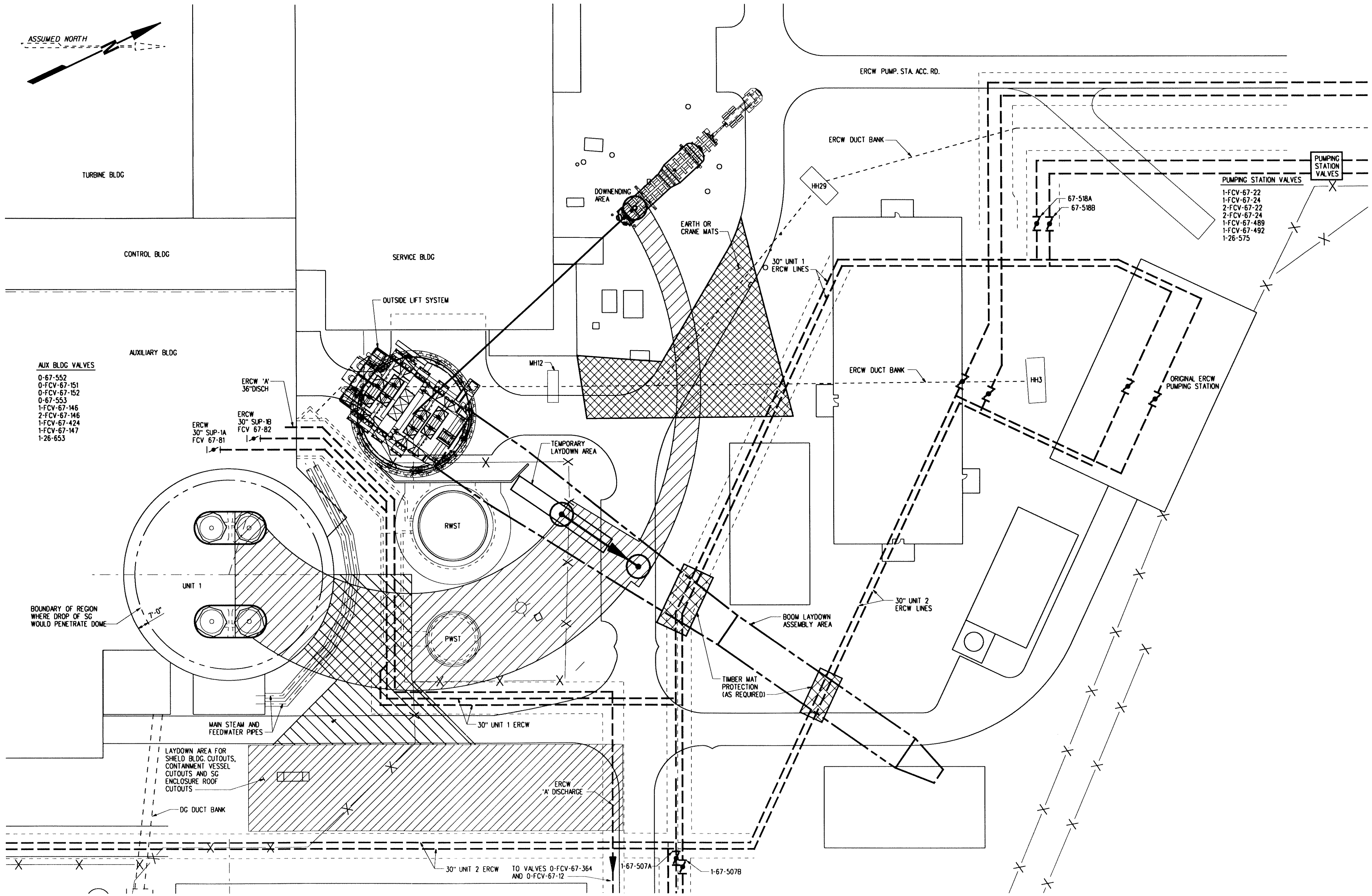

Figure 5-2 – Outside Lift System Location

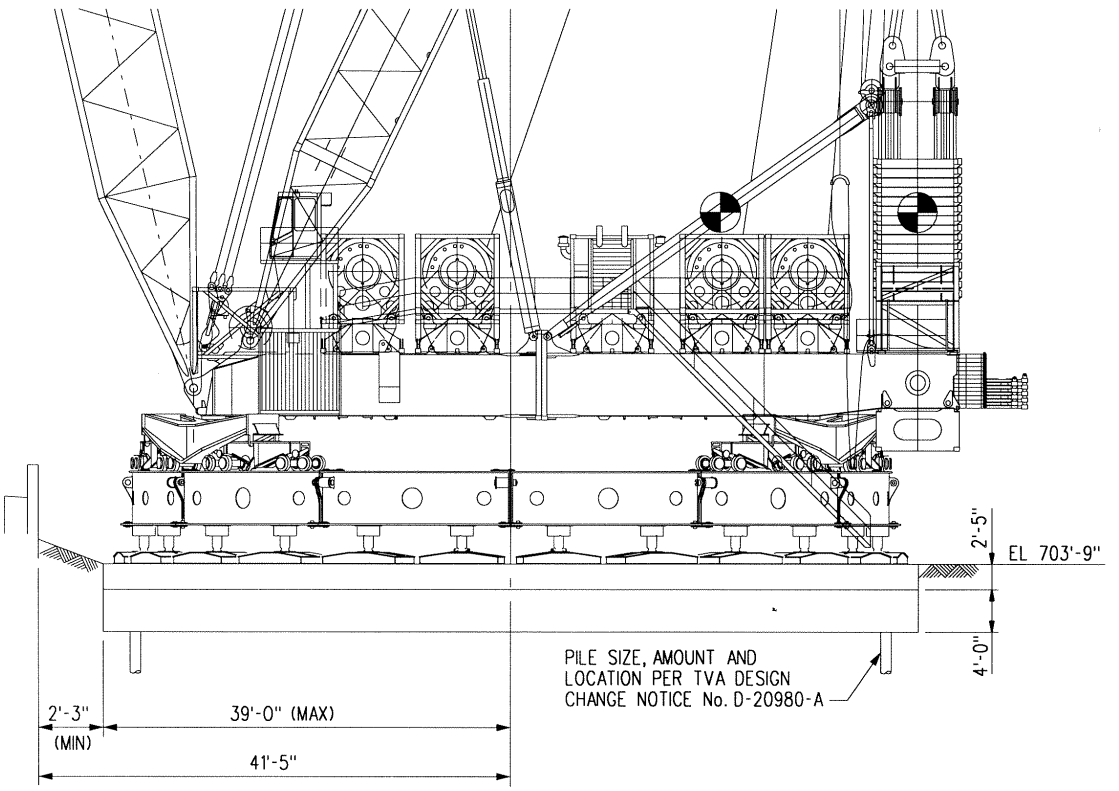

Figure 5-3 – Outside Lift System Base Elevation

6.0 Description of SSCs Potentially Affected by a Postulated Load Drop

To support the Unit 1 SGR, movement of heavy loads in the vicinity of, and over, safety-related equipment required to support operation of both units is required in Modes 1 through 6 and while defueled. The SSCs that are potentially affected from either equipment impact or a heavy load drop impact are identified in this section. The potentially affected design functions and operability requirements of these SSCs are also addressed. As detailed in Sections 7 and 8, the movement of loads in the vicinity of and over these SSCs has been evaluated and found acceptable based on the capability of the SSC to withstand the impact, protection being provided, and/or compensatory measures being implemented.

6.1 Containment

The Sequoyah Unit 1 Containment consists of a free-standing Steel Containment Vessel (SCV) surrounded by a free-standing concrete Shield Building. The SCV and Shield Building are designed to Seismic Category I standards to remain functional during and after a SSE. The design function of the SCV, as indicated in UFSAR Sections 3.8.2.1, 6.1 and 6.2.4, is to provide an essentially leak-tight barrier to the release of fission products to the environment. As described in UFSAR Section 3.8.1.1, the Shield Building is a reinforced concrete structure. The design function of the Shield Building is to protect the SCV from external events and to act as the principal structure that limits doses from radioactivity inside the Containment. These design functions are not required while the reactor is defueled.

Unit 1 Technical Specifications (TSs) 3/4.6.1.1, 3/4.6.1.6, and 3/4.6.1.7 specify the integrity requirements for the SCV and Shield Building during Modes 1-4. The bases for TSs 3/4.6.1.1, 3/4.6.1.6, and 3/4.6.1.7 indicate that the safety design basis for Primary Containment is that the Containment must withstand the pressures and temperatures of the limiting design basis accident without exceeding design leakage rates.

Unit 1 TS 3/4.6.2.2 requires that two independent trains of lower Containment vent coolers be operable with two coolers in each train in Modes 1-4. The bases for TS 3/4.6.2.2 indicate that the operability of the lower Containment vent coolers ensures that adequate heat removal capacity is available to provide long-term cooling following a non-LOCA event.

Unit 1 TS 3/4.6.3 requires that each Containment isolation valve be operable in Modes 1-4. The bases for TS 3/4.6.3 indicate that operability of the Containment isolation valves ensures that the Containment atmosphere will be isolated from the outside environment in the event of a release of radioactive material to the Containment or pressurization of the Containment.

Unit 1 TS 3/4.9.4 defines the required status of Containment Building penetrations during movement of irradiated fuel within the Containment. The bases of TS 3/4.9.4 indicate that the requirements on Containment Building penetration closure and operability ensure that a release of radioactive material within Containment will be restricted from leakage to the environment.

6.2 Auxiliary Building

The Auxiliary Building will not be directly impacted by the evaluated load drops. However, a potential effect from the postulated load drops is flooding of the Auxiliary Building through the ERCW tunnel. The impact of potential flooding on the Auxiliary Building is addressed in Section 7.1. Measures that mitigate this flooding are detailed in Section 8.

As described in UFSAR Section 3.8.4.1.1, the Auxiliary Building is a part of the Auxiliary Control Building. It is a multi-story reinforced concrete structure that provides housing for Unit 1 and 2 Engineered Safety Features equipment. The Spent Fuel Pit and Fuel Transfer Canal are also housed in the Auxiliary Building. The Auxiliary Building is designed to Seismic Category I standards and will remain functional during and after a SSE. The exterior concrete walls above grade are designed to resist the design basis tornado missiles. Since the Auxiliary Building is shared between Unit 1 and Unit 2, these design bases are required whenever either unit is in Modes 1-4 or fuel is stored in the Spent Fuel Pool.

6.3 Essential Raw Cooling Water System

As described in UFSAR Section 9.2.2.2, the ERCW system consists of eight pumps, four water traveling screens, four screen wash pumps, and four strainers located within the ERCW pumping station, and associated piping and valves. The safety-related portion of the ERCW system is designed to Seismic Category I standards and will remain functional following the SSE. Water is supplied to the Auxiliary Building from the ERCW pumping station through four independent sectionalized supply headers designated as 1A, 1B, 2A, and 2B. Four ERCW pumps are assigned to train A and four are assigned to train B. The two headers associated with the same train (i.e., 1A/2A or 1B/2B) may be cross-tied to provide greater flexibility. This allows one supply header to be out of service (e.g., for strainer maintenance), subject to the Ultimate Heat Sink limitations of TS 3/4.7.5. Section 9.2.2 of the UFSAR indicates that the ERCW system design function is to supply cooling water to various heat loads in both the primary and secondary portions of each unit. A simplified flow diagram of the ERCW system is provided as Figure 6-1. Figure 6-1 also depicts the impact locations of the postulated load drop of an SG based on the load path indicated on Figure 5-2. Note that three ERCW lines run in parallel under the load path resulting in three impact locations on Figure 6-1.

The ERCW system piping is arranged in four headers (1A, 1B, 2A, and 2B) each serving certain components in each unit as follows:

1. Each header supplies ERCW to one of the two Containment Spray heat exchangers associated with each unit.
2. The primary cooling source for each of the Diesel Generator heat exchangers is from the Unit 1 headers. Each diesel also has an alternate supply from the Unit 2 headers of the opposite train.
3. The normal cooling water supply to Component Cooling System (CCS) heat exchangers 1A1 and 1A2, 2A1 and 2A2, and 0B1 and 0B2, is from ERCW headers 2A, 2A, and 2B, respectively.
4. Each A and B supply header in each unit header provides a backup source of Feedwater for the turbine-driven Auxiliary Feed Pumps in the respective unit.

5. Each of the two discharge headers provides a backup source of Feedwater for the motor-driven Auxiliary Feedwater Pumps in each unit.
6. Headers 1A and 1B provide ERCW cooling water to the Control Room and Control Building electrical board room air-condition systems.
7. Each A and B header in each unit supplies ERCW cooling water to the Auxiliary Building ventilation coolers for safeguard equipment, the Containment ventilation system coolers, the Reactor Coolant Pump (RCP) motor coolers, the control rod drive vent coolers, and the Containment instrument room cooler's water chillers in the respective unit.
8. Headers 1A and 1B provide a normal and backup source of cooling water for the Station Air Compressors.
9. Headers 1A and 2B provide ERCW cooling water for the Shutdown Board room air-conditioners and Auxiliary Control Air Compressors.
10. Headers 2A and 2B provide ERCW cooling water for the Emergency Gas Treatment room coolers and boric acid transfer and Unit 2 Auxiliary Feedwater Pump space coolers.
11. Headers 1A and 1B provide ERCW cooling water for the CCS pumps and Unit 1 Auxiliary Feedwater Pump space coolers.
12. Under flood conditions, each header would provide water to the Spent Fuel Pit heat exchangers, Reactor Coolant Pump thermal barriers, ice machine refrigeration condensers, and sample heat exchangers, and the Residual Heat Removal heat exchangers as needed.

The headers are arranged and fitted with isolation valves such that a rupture in a header can be isolated and will not jeopardize the safety functions of the other headers. The layout of ERCW piping and key isolation valves relative to the heavy load paths is provided on Figure 5-2. The operation of two pumps on one plant train is sufficient to supply cooling water requirements for the 2-unit plant for unit cooldown, refueling, or post-accident operation. However, additional pumps may be started, if available, for unit cooldown or refueling. Two pumps per train operate during the hypothetical, combined accident and loss of normal power if each Diesel Generator is in operation. In an accident the Safety Injection signal automatically starts two pumps on each train, thus providing full redundancy. This arrangement assures adequate cooling water under both normal and emergency conditions.

TS 3/4.7.4 (both units have the same TS requirements) requires that at least two independent ERCW loops be operable in Modes 1-4. The bases of TS 3/4.7.4 indicate that the operability of the ERCW system ensures that sufficient cooling capacity is available for continued operation of safety-related equipment during normal and accident conditions. The Unit 1 systems that require ERCW are not required to be operable while the reactor is defueled.

6.4 Refueling Water Storage Tank

As discussed in UFSAR Section 3.8.4.1.4, the Refueling Water Storage Tank (RWST) is a Seismic Category I structure, but is not tornado missile protected. Pipes from the RWST to the Auxiliary Building are housed in reinforced concrete tunnels. A storage basin is provided around the RWST to retain a quantity of borated water in the event the RWST is ruptured by a tornado missile or other initiating event.

The design function of the RWST, as indicated in UFSAR Sections 5.5.7.2.2, 6.3.2.2 and 6.3.3.12, is to provide borated water for (1) filling the Refueling Canal during refueling and (2) the Safety Injection, Residual Heat Removal, and Containment Spray pumps during the Emergency Core Cooling System (ECCS) function. These design functions are not required while the Reactor is defueled.

UFSAR Table 6.3.2-3 provides the minimum storage volume for the accumulators and RWST. As indicated in UFSAR Section 6.3.2.6, this minimum storage volume is sufficient to ensure that after a RCS break, sufficient water is injected and is available within the Containment to permit recirculation flow to the core, and to meet the net positive suction head requirements of the RHR pumps.

Unit 1 TS 3/4.5.5 requires the RWST to be operable in Modes 1-4. The bases for TS 3/4.5.5 indicate that the operability of the RWST as part of the ECCS ensures that a sufficient supply of borated water is available for injection by the ECCS in the event of a LOCA.

6.5 Primary Water Storage Tank

As indicated in UFSAR Section 12.1.2, the Primary Water Storage Tank (PWST) is one of the outside tanks used to store low-level radioactive liquids. It is a non-seismic, non-tornado missile protected, non-safety related tank. Section 11.2.3 of the UFSAR indicates that the PWST has a high level alarm and an overflow line that discharges to the ERCW pipe tunnel.

6.6 Main Steam Lines

UFSAR Section 10.3 describes the Main Steam supply system. The system is designed to conduct steam from the Steam Generator outlets to the High Pressure Turbine, the Condenser Steam Dump system, and to other components. Downstream of the Main Steam Isolation Valves (MSIVs), the steam lines follow the outside perimeter of the Shield Building until they enter the Turbine Building.

As described in UFSAR Section 10.3.2.1, the MSIVs and Main Steam Bypass Isolation Valves are provided to protect the plant following a break in the steam header downstream of the MSIVs. UFSAR Section 3.5.5 states that tornado missile protection is not required for the portion of the Main Steam piping downstream of the MSIVs.

Unit 1 TS 3/4.7.1.5 requires that four MSIVs be operable in Modes 1-3. The bases for TS 3/4.7.1.5 indicate that the operability of the MSIVs ensures that no more than one Steam Generator will blowdown in the event of a steam line rupture.

6.7 Feedwater Lines

As described in UFSAR Section 10.4.7.1, the Condensate Feedwater system is designed to supply a sufficient quantity of feedwater to the Steam Generator secondary side inlet during normal operating conditions and to guarantee that feedwater will not be delivered to the Steam Generators when feedwater isolation is required. The portion of the system from the Steam Generators back through the check valve and isolation valve is designed as TVA Class B.

Unit 1 TS 3/4.7.1.6 requires that four Main Feedwater Isolation Valves (MFIVs), four Main Feedwater Regulating Valves (MFRVs), and four MFRV Bypass Valves be operable in Modes 1-3. The bases for TS 3/4.7.1.6 indicate that isolation of the Main Feedwater system is provided when required to mitigate the consequences of a steam line break, feedwater line break, excessive feedwater flow, and loss of normal feedwater (and station blackout) accident.

6.8 Fire Protection System Piping

Section 12.1 of Part II of the Sequoyah Fire Protection Report (FPR) indicates that the High Pressure Fire Protection (HPFP) system water supply is common to both units and consists of one electric motor driven fire pump and one diesel engine driven fire pump. Each pump takes suction from its own 300,000 gallon potable water storage tank which is supplied by the local municipal utility. Each pump is connected to the HPFP system looped yard main by a separate supply line that can be isolated.

A fire protection water distribution system is provided to serve both units and is cross-tied between the units. Sectional isolation valves are provided so that maintenance may be performed on portions of the loop while maintaining fire fighting capability. The sectional isolation valves in the underground loop are locked or sealed in position and surveillance is performed to ensure proper system alignment.

The HPFP system is also connected to the two fire/flood mode pumps (old fire pumps) which can be utilized by opening the normally closed valves which isolate them from the system. These pumps are not required for the HPFP system to fulfill its design bases.

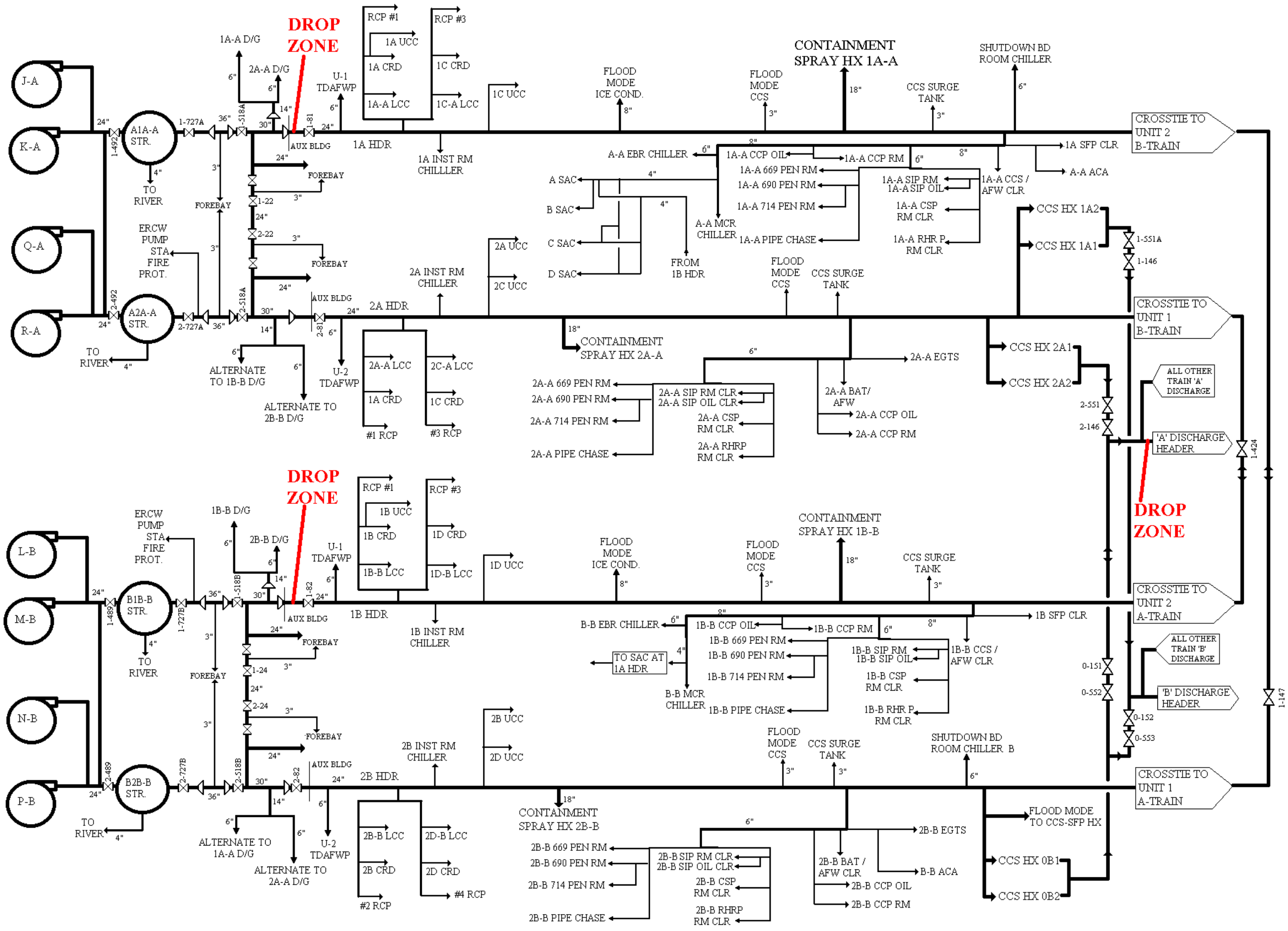

Figure 6-1 – Simplified ERCW Flow Diagram

7.0 Postulated Load Drops

Details of the design of the cranes being used (including their seismic capability), inspections and load testing performed on these cranes, restrictions on operation of the cranes, operator training, and procedural controls have been provided in the previous sections. Given these considerations, it is highly unlikely that a load will be dropped from these cranes. However, as required by NUREG-0612, load drops from each of these cranes have been postulated and the potential consequences of these postulated drops evaluated.

Rigging of the heavy loads described in Section 5 will be performed within the load paths defined on Figure 5-2. In the event of a non-mechanistic failure of a crane or rigging equipment resulting in a load handling accident, the load is assumed to impact within the evaluated load path.

As detailed in Section 5, the heaviest loads being handled are the Steam Generators. Other significant loads include Shield Building concrete sections, Containment Vessel steel sections, Steam Generator Compartment roof concrete sections, and OLS components during assembly/disassembly.

7.1 Steam Generator Load Drops

<u>SG Drop Above Containment</u>

Two SG load drop situations above the Containment have been considered; those within a radial distance from the center of Containment of about 60 ft. (remote from Containment Building ~131 ft. diameter cylindrical shell wall) and those between this region and the parapet (near the cylindrical shell wall). Since the Unit 1 Reactor will be defueled while the SGs are being moved, the primary concern with a SG drop is the SG trajectory following impact with the Shield Building dome and its subsequent impact location.

SG Drop Above Containment – Away From Shield Building Wall

The SG drop trajectory following vertical impact from an arbitrary height onto the dome is difficult to predict. Since the lift height of the SG is only limited by the capability of the OLS, a substantial clearance between the SG and the Shield Building dome will be maintained by lifting the SGs vertically through the Containment openings until a defined minimum clearance is attained. The SGs will then be translated horizontally to the outer edge of the Containment as shown on Figure 5-2. Applying an energy balance methodology to a rigid-plastic shell model, it was analytically determined (Reference 26) that a SG drop from a height of 12.75 ft. or greater will perforate the concrete Containment shield wall and SCV. A drop from this height ensures complete penetration of the SG through the dome and into the Containment Building, as opposed to a response characterized by impact with and deflection off the Containment dome. A minimum clearance from the Shield Building dome of 20 ft. will be used when lifting the SGs. This 20 ft. clearance is within the lifting limit of the OLS. Some substantial conservatisms support the conclusion that perforation and entry will occur. These conservatisms are: 1) neglect of energies associated with local deformations, 2) consideration of the “laminar” concrete dome as a contiguous or single layer, 3) neglect of the weakening effect of the openings, and 4) use of a lift height (20 ft.) that is 50% higher than that calculated for perforating the dome.

SG Drop Above Containment – Near Shield Building Wall

As the SGs near the edge of the Containment, it no longer becomes possible to analytically show that the SG penetrates the Containment dome. At this point, a dropped SG is assumed to tumble over the edge of the Containment and impact the ground somewhere near the Shield Building wall along the load path. It may also impact the side of the Shield Building as it falls. Since it is difficult to predict exactly where the SG will impact, SSCs within and near the load path were assumed to be affected. The potentially affected SSCs in the vicinity of this postulated drop location are the Unit 1 Shield Building, ERCW tunnel and pipes, RWST, PWST, MS piping, FW piping, and Fire Protection System piping.

<u>SG Drop Along Shield Building Wall</u>

The SGs will be lowered/raised by the OLS near the Shield Building wall above the load path shown on Figure 5-2. A SG drop in this area is assumed to impact directly below where the SG is being lowered/raised. Since the impact area is bounded by the area assumed for the postulated SG drop above the Containment near the Shield Building wall, the consequences of the drop along the Shield Building wall are also bounded.

<u>SG Drop Between Lowering/Raising Area and Downending/Upending Area</u>

A SG drop along the load path between the lowering/raising area and the downending/upending area is assumed to impact SSCs within the flopover distance (approximately 70 ft. from the impact point on the load path) of the SG. In addition to those SSCs potentially affected by the SG drop above Containment near the Shield Building wall, this postulated drop could also affect the two ERCW ductbanks shown on Figure 5-2. These ductbanks contain ERCW cables associated with trains A and B of both units.

<u>SG Drop Dose Consequences</u>

Since it is more conservative from a dose standpoint to assume a failure of the OSG outside Containment, Reference 23 determined the radiological consequences of a Steam Generator drop outside Containment along the load path between the Containment and the OSGSF.

The acceptability of the offsite dose consequences associated with a postulated drop of an OSG has been evaluated and compared to the consequences of postulated design basis accidents for a gaseous release. For assessing offsite dose consequences, the drop of an OSG is considered to most closely resemble a rupture of a tank containing radioactive material. Failure of the Waste Gas Decay Tank (WGDT) (Reference UFSAR Section 15.3.5) is the limiting event currently evaluated in the UFSAR for accidental gaseous release from a tank. As indicated in UFSAR Section 15.5.2, the gamma, beta, and thyroid doses at the EAB from a WGDT failure are 2.5 Rem, 5.8 Rem, and 5.9×10^{-2} Rem, respectively. The gamma, beta, and thyroid doses at the LPZ are 0.29 Rem, 0.68 Rem, and 6.9×10^{-3} Rem, respectively.

Reference 23 conservatively assumed that 10% of the Steam Generator activity is released due to the impact of the drop and 1% of this release amount is in the form of particulates small enough to become airborne. Confirmatory NRC analyses of the early

SGRs also used this percentage of activity release. Based on an isotopic survey of the CVCS, the prime contributors to the offsite dose due to a SG drop were determined to be Ni-63, Co-60, Cs-134 and Cs-137. Using these conservative assumptions, the maximum calculated Control Room dose is 3.76×10^{-2} Rem whole body. The offsite doses from a postulated drop at the limiting location along the haul route are 4.86×10^{-2} Rem whole body (correlates to the WGDT gamma dose) and 3.02×10^{-4} Rem to the skin (correlates to the WGDT beta dose) at the EAB and 4.63×10^{-3} Rem whole body (correlates to the WGDT gamma dose) and 1.3×10^{-3} Rem to the skin (correlates to the WGDT beta dose) at the LPZ. A thyroid dose was not calculated since the SG dose is primarily due to activated corrosion products and contains no iodine.

UFSAR Section 15.5.2 presents the radiological consequences of a WGDT rupture in the context of 10CFR100. However, in NRC Standard Review Plan (SRP) Section 11.3, the WGDT radiological consequences are limited per the guidance of Branch Technical Position (BTP) ETSB 11-5. BTP ETSB 11-5 establishes an offsite dose limit of 0.5 Rem whole body which at the time of issuance was consistent with 10CFR20 limits. The Technical Specifications acknowledge this regulatory criterion by placing an activity limit on the WGDTs (Reference Technical Specification 3/4.11.2.6 and the associated bases) to ensure the whole body exposure of 0.5 Rem to an individual in an unrestricted area is not exceeded. This limit on dose is greater than the calculated dose for an OSG drop. The evaluated consequences of an OSG drop are within the applicable regulatory criteria of BTP ETSB 11-5 and are much less than the limiting licensing design basis accidents currently evaluated in Chapter 15 of the UFSAR.

Auxiliary Building Flooding

As indicated above, a postulated OLS load drop could affect the ERCW tunnel and pipes, RWST, PWST, and Fire Protection System piping. The failure of any of these tanks and pipes could result in flooding of the Auxiliary Building via the ERCW pipe tunnel. UFSAR Section 9.3.3.7 states that the Auxiliary Building has a passive sump that collects water from annulus drain sumps, and blowout panels located in the floors of the pipe chases and the Containment Spray and RHR pump rooms. Per UFSAR Section 6.3.2.11, the passive sump has a capacity of 209,000 gallons and a water level sensor in the passive sump alarms in the Main Control Room. Compensatory measures to preclude flooding of safety-related equipment in the Auxiliary Building following a postulated heavy load drop are described in Section 8.

7.2 Shield Building Concrete Section Load Drops

As indicated in Section 5.5, the Shield Building concrete sections will be approximately 20 ft. by 45 ft. and will weigh less than 132.5 tons (265 kips). These sections will follow the load paths shown on Figure 5-2. Unlike the SGs, they will only be raised a maximum of three feet above the Containment dome. This lift height and the inherent shape of the concrete sections will eliminate the potential for them to rebound from the Containment in an unanticipated direction. Given that the size and mass of these concrete sections are bounded by the SGs, the consequences of a Shield Building concrete section load drop are bounded by the SG drops described in Section 7.1.

7.3 Containment Vessel Steel Section Load Drops

As indicated in Section 5.5, the Containment Vessel steel sections will be approximately 20 ft. by 45 ft. and weigh no more than 15 tons (30 kips). These sections will follow the load paths shown on Figure 5-2. Unlike the SGs, they will only be raised a maximum of three feet above the Containment dome. This lift height and the inherent shape of the SCV sections will eliminate the potential for them to rebound from the Containment in an unanticipated direction. Given that the size and mass of these steel sections are bounded by the SGs, the consequences of a Containment Vessel steel section load drop are bounded by the SG drops described in Section 7.1.

7.4 Steam Generator Compartment Roof Plug Load Drops

As indicated in Section 5.5, the Steam Generator Compartment roof concrete sections will be 18-20 ft. in diameter and will weigh less than 65 tons (130 kips). These sections will follow the load paths shown on Figure 5-2. Unlike the SGs, they will only be raised a maximum of three feet above the Containment dome. This lift height and the inherent shape of the concrete sections will eliminate the potential for them to rebound from the Containment in an unanticipated direction. Given that the size and mass of these concrete sections are bounded by the SGs, the consequences of a Steam Generator Compartment roof plug concrete section load drop are bounded by the SG drops described in Section 7.1.

7.5 Outside Lift System Component Load Drops

As indicated in Section 5.3, the OLS components vary in size and weight. These components will be handled in the OLS assembly/disassembly area shown on Figure 5-2. The crane components will be off-loaded from the tractor-trailers using lattice boom and/or truck cranes and forklifts. During the offload process, the components will be lifted slightly higher than the trailer bed and lowered to the ground. Offloading locations used will minimize the potential for impacting the RWST and ERCW piping. When it is not possible to eliminate a potential impact with the ERCW piping, timber mats (as detailed in Section 8.3) will be used to distribute the impact from a load drop. The consequences of OLS component load drops have been evaluated to be acceptable based on provision of this protection.

8.0 Heavy Load Drop Protection Plans/Compensatory Measures

Section 4 details the regulatory requirements/criteria that are relevant to the handling of heavy loads over safety-related equipment and summarizes conformance with these requirements/criteria. As discussed in Section 4.2, Section 5.1.5 of NUREG-0612 indicates that the effects of load drops should be analyzed (in accordance with the guidelines of Appendix A to NUREG-0612) and the results should indicate that damage to safe shutdown equipment is not sufficient to preclude safe shutdown.

Each of the potentially affected SSCs identified in Section 6 has been analyzed in accordance with the NUREG-0612 guidance to determine the effects of a load drop. Summarized below is the protection required to preclude an adverse effect and/or the actions or compensatory measures required to mitigate these effects should a load drop occur. Provision of the identified protection and taking the specified actions and compensatory measures assures that safe shutdown can be achieved following a load drop. In addition, it will be confirmed that the assumptions made within this Topical Report regarding the status of the station are valid prior to load handling activities.

8.1 Containment

The heavy loads of concern that will be handled above the Containment will only be moved while the Unit 1 reactor is defueled. With fuel removed from the Containment, the only other safety issue is whether a load drop into the Unit 1 Containment will affect systems common to both units that pass through the Unit 1 Containment. To preclude a SG drop inside the Unit 1 Containment from affecting Unit 2, the ERCW system and Component Cooling System (CCS) shall either be isolated or be capable of being isolated with valves located outside of Containment. In addition, the Spent Fuel Pit (SFP) shall be isolated from the Unit 1 containment.

8.2 Auxiliary Building

Heavy loads will not be handled over the Auxiliary Building and, as discussed in Sections 7.1, 7.2, 7.3, and 7.4, will not roll off the Containment roof onto the Auxiliary Building. Therefore, no additional protection of the Auxiliary Building roof is required.

To preclude flooding of the Auxiliary Building due to a heavy load drop a wall (see Figure 8-1) will be installed in the ERCW tunnel near the Auxiliary Building interface. A door will be provided as part of the wall to allow access to the tunnel, if required. The wall has been designed for the hydrostatic head generated if the tunnel was completely filled with water and an impact load associated with the rushing water just after a pipe break. Installation of this wall will be completed prior to movement of heavy loads that could cause a failure of the piping and tanks that penetrate the ERCW pipe tunnel.

8.3 Essential Raw Cooling Water System

<u>Unit 1 ERCW Supply Piping and Train A Discharge Piping</u>

As noted in Section 6.3, Section 9.2.2 of the UFSAR indicates that the ERCW system design function is to supply cooling water to various heat loads in both the primary and secondary portions of each unit. The Unit 1 ERCW system piping near the Unit 1 Containment would likely fail (i.e., crimp or rupture) as a result of the postulated load drops detailed in Sections 6.1, 6.2, 6.3, and 6.4.

The postulated heavy load drop from the OLS might result in the failure of the Unit 1 ERCW trains A and B supply and/or ERCW train A discharge piping for both units. Prior to isolating damaged ERCW piping, ERCW flow to the following significant components are among those that may be lost:

- Centrifugal charging pumps
- Safety injection pumps
- Diesel generators
- Control air compressors
- Auxiliary air compressors
- Main control room chillers
- Electrical board room chillers
- Shutdown board room chillers
- Component cooling system pump space coolers
- Component cooling system heat exchangers

Following isolation of the Unit 1 ERCW train A and B supply, ERCW flow to the following significant components, are among those that may be lost:

- Diesel generators (normal feeds)
- Control air compressors
- Train A auxiliary air compressor
- Main control room chillers
- Electrical board room chillers
- Component cooling system pump space coolers

The following lost functions can be recovered by supplying ERCW from the opposite train, Unit 2 headers as follows:

- Closing 1-FCV-67-82, then opening 1-FCV-67-424. This will allow water to flow from the Unit 2 train A ERCW header to the Unit 1 train B ERCW auxiliary building header and restore the train B Main Control Room and electrical board room chillers and all of the control and service air compressors to service.
- Closing 1-FCV-67-81, then opening 1-FCV-67-147. This will allow water to flow from the Unit 2 train B ERCW header to the Unit 1 train A ERCW auxiliary building header and restore the train A Main Control Room and electrical board room chillers and all the control and service air compressors to service, including the train A auxiliary air compressor.

Mitigation of this assumed ERCW piping failure following a postulated heavy load drop requires that compensatory measures be implemented to isolate the affected Unit 1 ERCW piping and restore ERCW flow to required equipment, as necessary. These compensatory measures will be proceduralized prior to use of the OLS for load handling. Personnel will be trained to implement the compensatory measures.

Due to the potential to adversely affect both trains of ERCW, an operability issue has been identified that requires a revision to Unit 2 TS 3/4.7.4 - ERCW System. The proposed TS change would add a note that states:

> "During U1C12, lifts of heavy loads are not considered to affect ERCW operability provided that they are performed in accordance with Topical Report 24370-TR-C-002 (including the prescribed compensatory measures)."

This note will be removed from the TSs after completion of U1C12.

Unit 2 ERCW Supply Piping

The Unit 2 30" ERCW pipes running parallel to the west side of the Solar Building and east of the Unit 1 Containment (see Figure 5-2) do not directly lie on the load path and are located approximately 128 ft. from the load path. They were evaluated in Reference 24 for the effects of impact energy due to a postulated drop of the SG at a distance away and transmitted to it by wave propagation through the soil. The worse case postulated impact location was determined to be located at least 63 ft. away from the nearest Unit 2 ERCW pipe. The peak particle velocity (PPV) of the shock wave at the ERCW piping from a load drop was determined using the scaled-distance wave propagation equation proposed by Wiss in Reference 14. The computed PPV was then used to estimate the free field soil pressure on the buried piping, which was then used to evaluate the adequacy of the ERCW pipe as a flexible pipe. Reference 24 concluded that the Unit 2

ERCW piping will not fail and will remain functional under the impact effects of the postulated SG drop at a distance away from the piping.

<u>ERCW Ductbanks</u>

As noted in Section 7.1, the load path for the SGs crosses over two buried ERCW ductbanks (one between manhole MH12 and handhole HH3 and the other between manhole MH12 and handhole HH29). The ductbanks contain cables associated with ERCW trains A and B for both units. Therefore, it is vital that a SG drop does not affect the functioning of these cables. These ductbanks have been evaluated in Reference 24 for impact loading from a direct vertical drop of the SG as well as from the subsequent flopover fall of the SG. In order to minimize the impact energy from a vertical drop of the SG, the bottom of the SGs will be carried at an elevation not to exceed 3 ft. above grade while traversing the load path at and near these ductbanks. The impact energy from the flopover fall was determined to be more critical than from a direct vertical drop of 3 ft.

In evaluating the ductbanks, the depth of penetration of the dropped SG into the soil and the resulting contact-pressure time history were estimated considering the bearing resistance of the soil stratum overlaying the ductbank using Meyerhoff's Bearing Capacity equations (Reference 25). Suitable attenuation of the surface pressures were considered based on Boussinesq's equation (Reference 25). The ductbanks were analyzed dynamically as beams on elastic foundation subjected to the attenuated pressure time-history. The ductbank loading and boundary conditions are appropriately specified. The total response of the ductbank was calculated using modal superposition in terms of deflection, shear and bending moment based on which the adequacy of the ductbank is assessed.

The evaluation in Reference 24 concluded that the ERCW ductbanks will remain adequate in the event of an SG drop if sufficient soil cover is available over the ductbanks. Therefore, additional soil fill protection will be provided in the potentially affected areas above the ductbanks where the grade elevation is lower so as to bring the grade to a sufficient height to protect the ductbanks.

8.4 Refueling Water Storage Tank

As noted in Section 6.4, the RWST is a Seismic Category I structure, but is not tornado missile protected. Pipes from the RWST to the Auxiliary Building are housed in reinforced concrete tunnels. A storage basin is provided around the tank to retain a quantity of borated water in the event the tank is ruptured by a tornado missile or other initiating event.

As shown on Figure 5-2, no heavy loads will be carried over the RWST by the OLS. Since a potential load drop from the OLS could only occur when Unit 1 is defueled, loss of the RWST function has no safety impact. However, a failure of the RWST piping in the pipe tunnel between the RWST and the Auxiliary Building could result in flooding in the Auxiliary Building. The passive sump in the Auxiliary Building has been sized to account for flooding from the RWST, but not concurrent with an ERCW piping failure in the pipe tunnel. To minimize the potential for flooding of the Auxiliary Building due to a failure of the RWST, PWST, and/or ERCW piping inside the pipe tunnel, a wall will be installed near the pipe tunnel opening into the Auxiliary Building. This wall will be installed prior to movement of loads with the OLS and will be capable of withstanding the hydrostatic and velocity head of water from the postulated piping failures and loads created by the nearby drop of a steam generator. It will also meet Sequoyah Seismic I (L) requirements, so that an earthquake would not cause a failure of nearby safety-related SSCs as a result of a seismically-induced failure of the wall.

The mobile cranes used for assembly/disassembly of the OLS will be positioned such that a load drop will not impact the RWST. Since the mobile cranes will be used while Unit 1 is in Modes 1-6, the positioning of these cranes away from the RWST assures that the RWST function will be available, if required.

8.5 Primary Water Storage Tank

As noted in Section 6.5 and shown on Figure 5-2, heavy loads will be carried over the PWST by the OLS. Since a potential load drop from the OLS could only occur when Unit 1 is defueled, loss of the PWST function has no safety impact. However, a failure of the PWST piping in the pipe tunnel between the PWST and the Auxiliary Building could result in flooding in the Auxiliary Building. To minimize the potential for flooding of the Auxiliary Building due to a failure of the RWST, PWST, and/or ERCW piping inside the pipe tunnel, a wall will be installed near the pipe tunnel opening into the Auxiliary Building. This wall will be installed prior to movement of loads with the OLS and will be capable of withstanding the hydrostatic and velocity head of water from the postulated piping failures and loads created by the nearby drop of a steam generator. It will also meet Sequoyah Seismic I (L) requirements, so that an earthquake would not cause a failure of nearby safety-related SSCs as a result of a seismically-induced failure of the wall.

8.6 Main Steam Piping

As noted in Section 6.6, the MS piping outside the Shield Building is a potentially affected SSC for the postulated load drops described in Section 7. Since a heavy load drop induced failure of the MS piping will be isolated by closure of the MSIVs, no protective measures are required.

8.7 Feedwater Piping

As noted in Section 6.7, the FW piping outside the Shield Building is a potentially affected SSC for the postulated load drops described in Section 7. Since a heavy load drop induced failure of the FW piping will be isolated by closure of the FW isolation valves, no protective measures are required.

8.8 Fire Protection System Piping

As noted in Section 6.8, the high-pressure fire pump and flood mode pump piping in the pipe tunnel is a potentially affected SSC for the postulated load drops described in Section 7. To minimize the impact of a rupture of this piping on flooding of the pipe tunnel, valves 1-26-575 and 1-26-653 will be closed prior to movement of heavy loads with the OLS. Closure of these valves minimizes the actions that need to be taken to isolate a break. Closing these valves will not affect plant operation.

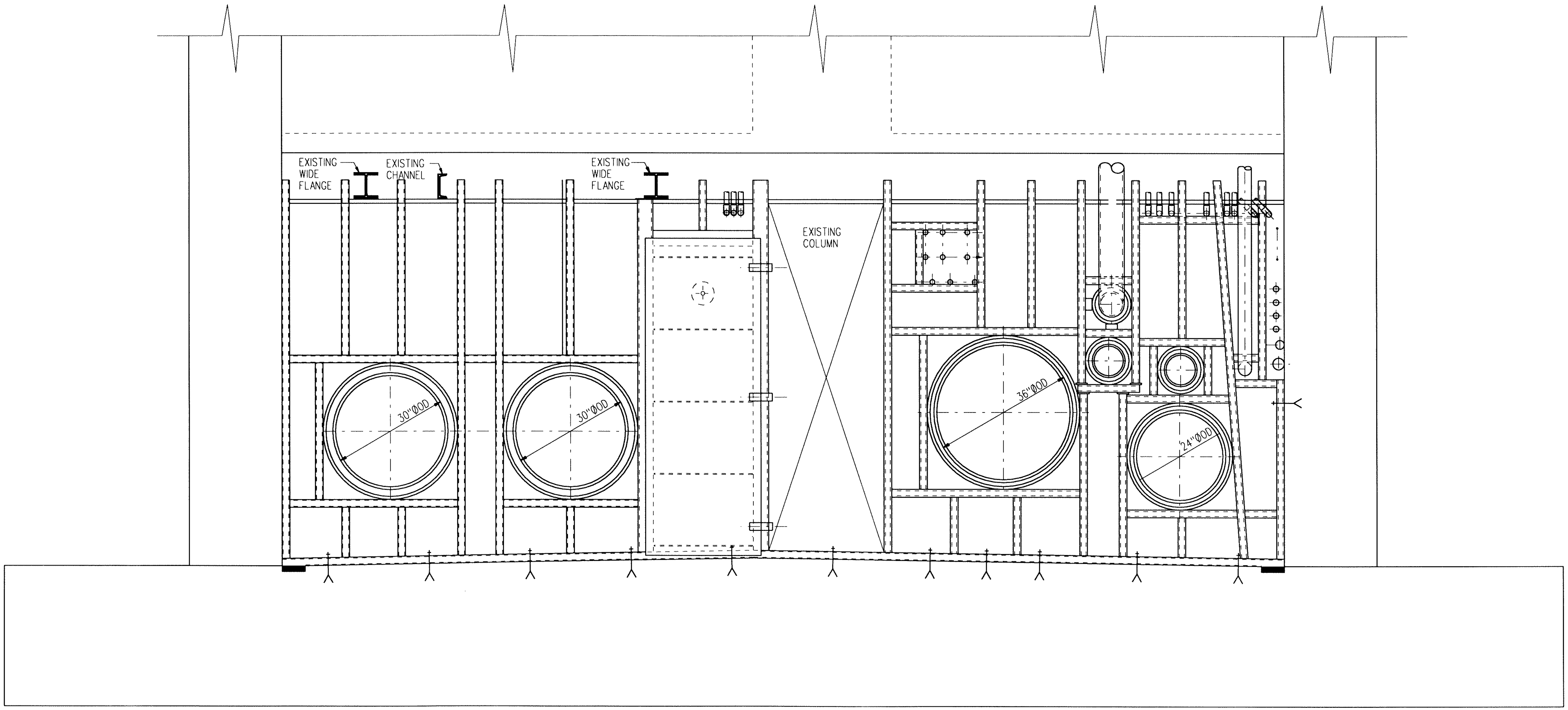

Figure 8-1 – ERCW Tunnel Wall

9.0 Summary and Conclusions

The Steam Generator Replacement at Sequoyah Unit 1 will involve the handling of heavy loads that are larger and must travel along load paths different from those evaluated during the original licensing of the plant. Paralleling the guidelines of NUREG-0612, a safe load path has been selected which generally moves the loads away from the plant and away from sensitive SSCs supporting the continued safe operation of the station. In a few cases, handling over equipment supporting safe shutdown could not be avoided. Therefore, the continued safety of the plant will be assured by:

- Equipment selection,
- Equipment evaluation for certain external events,
- Operator training, and
- Procedural controls, including lift heights, load paths, and limitations related to weather conditions.

Due to the potential to adversely affect both trains of ERCW, an operability issue has been identified that requires a revision to Unit 2 TS 3/4.7.4. The proposed TS change is required to support Unit 2 operation while loads are being handled by the OLS.

Based upon these considerations and the relatively short periods of time that loads will be suspended over safe shutdown equipment, the risk associated with the drop of a heavy load as discussed in this Topical Report is considered to be small. However, as further protection from the postulated load drop: 1) protection will be provided from secondary flooding effects that could occur as a result of the postulated load drop, and 2) compensatory measures that will be implemented in the event of a load drop have been developed and will be proceduralized for use during the SGRO. These measures provide assurance that the operating unit can be safely shut down in the event of a heavy load drop. Further, as concluded in Appendix B, these compensatory measures and proposed TS change do not involve a significant hazards consideration.

10.0 References

1. Sequoyah Updated Final Safety Analysis Report, Amendment 16.
2. Sequoyah Nuclear Plant Unit 1 Technical Specifications
3. Sequoyah Nuclear Plant Unit 2 Technical Specifications
4. Design Criteria Document No. SQN-DC-V-7.4, “Essential Raw Cooling Water System”, Rev. 19.
5. System Operating Instruction No. 0-SO-67-1, “Essential Raw Cooling Water”, Rev. 38.
6. Abnormal Operating Procedure AOP-M.01, “Loss of Essential Raw Cooling Water”, Rev. 4.
7. Bechtel Supplier Document 24370-SC-004-PTCManual-001, “Users Manual – Platform Twin-Ring Containerized Crane”, Rev. 0.
8. Maintenance Instruction 0-MI-MXX-000-026.0, “Control of Heavy Loads in Critical Lifting Zones, NUREG-0612, C.1”, Rev. 8.
9. Procedure MMDP-2, “Safe Practices for Operation of Overhead Handling Equipment”, Rev. 1.
10. ASME NQA-1, Subpart 2.15, “Quality Assurance Requirements for Hoisting, Rigging, and Transporting of Items for Nuclear Power Plants”, 1997 Edition.
11. ASME B30.5, “Mobile and Locomotive Cranes”, 1994 and 2000 Editions.
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13. NRC Bulletin 96-02, “Movement of Heavy Loads Over Spent Fuel, Over Fuel in the Reactor Core, or Over Safety-Related Equipment”, April 11, 1996.
14. Wiss, J.F., Construction Vibrations: State-of-the-Art, Journal of the Geotechnical Engineering Division, ASCE, Volume 107, No. GT2, February 1981, pp. 167-181.
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17. Moser, A.P., Buried Pipe Design, McGraw Hill Inc., 1990.
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22. Calculation 24370-C-039, “Foundation for Upending/Downending Device”, Revision 0.
23. Calculation 24370-M-002, “Old Steam Generator Drop Dose Analysis”, Revision 0.
24. Calculation 24370-C-025, “Evaluation of Safety-Related Buried Commodities in the Vicinity of Heavy Lift Load Path for Postulated Load Drop from OLS”, Revision 1.
25. Bowles, J.E., Foundation Analysis and Design, Fourth Edition, McGraw Hill, Inc., 1988.
26. Calculation 24370-C-022, “Evaluation of SG Drop on Containment Shell”, Revision 0.
27. Calculation CSG-87-018, “5% Damped Free Field Top of Soil Response Spectra, SQN Units 1 & 2”, Revision 0.

Appendix A
NRC Commitments

There are a number of actions required to support the conclusions of Topical Report 24370-TR-C-002. The below listed actions ensure prerequisite actions to heavy load movement, active monitoring during heavy load movement, and protective actions in response to the unlikely event of a heavy load drop are in place. These actions are NRC commitments as listed below:

Prerequisite Actions to Heavy Load Movement

1. Install temporary pressure and flow gauges in selected locations of the Unit 1 ERCW piping.

2. Install a wall in the Unit 1 pipe tunnel to seal the tunnel from the Auxiliary Building. Develop criteria to quantify the amount of water behind the temporary pipe tunnel wall.

3. Realign the ERCW system to minimize operator actions in the event of a heavy load drop.

4. Realign the Component Cooling Water system to provide spent fuel pool cooling from Unit 1 to Unit 2 for Spent Fuel Pool operation.

5. Isolate the high-pressure fire pump and the flood mode pump piping in the pipe tunnel to the Auxiliary Building.

6. Isolate systems shared with Unit 2 or verify that they are capable of being isolated following a load drop, prior to handling a load over the Containment with the outside lift system.

7. Ensure that measures are in place to suitably handle any leakage through the temporary Unit 1 pipe tunnel wall.

Active Monitoring Actions During Heavy Load Movement

1. Monitor weather conditions, for the expected duration of the lift, to ensure conditions are acceptable for outside lift system operation.

2. Monitor outside lift system operation to ensure a minimum clearance of 20 feet exists between the Shield Building dome and the bottom of the steam generator when a steam generator is being moved over the Shield Building.

Actions in Response to the Unlikely Event of a Heavy Load Drop

1. Develop and issue plant procedure(s) to delineate specific actions required in case of a heavy load drop.

Appendix B
No Significant Hazards Consideration Determination

I. DESCRIPTION OF THE PROPOSED CHANGE

The four steam generators of the Sequoyah Nuclear Plant Unit 1 will be replaced during the spring of 2003. To support the replacement of the old steam generators (OSGs) with the replacement steam generators (RSGs), several heavy loads will be moved over safety-related structures, systems, and components (SSCs). While many of these SSCs would be called upon to perform a safety function during the time of the subject lifts, the ERCW system is a safety-related system that is common to both units. During the Unit 1 Steam Generator Replacement Outage (SGRO), the ERCW system will be supporting continuous operation and safe-shutdown capability for Unit 2.

Mitigation of the assumed ERCW piping failures following a postulated heavy load drop requires that compensatory measures be implemented to isolate the affected ERCW piping and restore ERCW flow to required equipment, as necessary. Due to the potential to adversely affect both trains of ERCW, an operability issue has been identified that requires a revision to Unit 2 Technical Specification (TS) 3/4.7.4 - ERCW System. The proposed TS change would add a note that states:

> "During U1C12, lifts of heavy loads are not considered to affect ERCW operability provided that they are performed in accordance with Topical Report 24370-TR-C-002 (including the prescribed compensatory measures)."

This note will be removed from the Unit 2 TSs after completion of U1C12.

II. REASON FOR THE PROPOSED CHANGE

As defined in NRC Bulletin 96-02, licensees planning to perform activities involving the handling of heavy loads over safety-related equipment while the reactor is at power and involving a potential load drop accident that has not previously been addressed in the FSAR should submit a license amendment request to the NRC. Following recent revisions to 10CFR50.59, the Bulletin's guidance was supplemented by NRC Regulatory Issue Summary 2001-03, which states that, "The fact that the load is larger or is moving in a different load path than previously evaluated would enter into the risk assessment required by 10CFR50.65(a)(4) and determine under what plant conditions the load lift should occur." The Sequoyah issues of interest are, perhaps, unique with respect to that guidance, in that during the Unit 1 SGRO, Unit 1-related maintenance/heavy load activities must be considered in light of their potential to influence the operation of Unit 2.

TVA Topical Report 24370-TR-C-002 documents the provisions made to ensure that heavy load handling activities associated with the Unit 1 SGRO can be accomplished without impacting the safe operation of Unit 2. These provisions support the risk assessment required by 10CFR50.65(a)(4) and an application for a one-time Unit 2 license amendment associated with the operability of the ERCW System.

III. SAFETY ANALYSIS

The Outside Lift System (OLS) that will be used to move the OSGs and RSGs during the Sequoyah Unit 1 SGRO (i.e., Mammoet PTC Heavy Lift Crane) is a commercial design.

The OLS was not specifically designed to withstand the external events addressed by 10CFR50, Appendix A, General Design Criterion (GDC) 2 that are a part of the Sequoyah design and licensing basis. However, due to the size of the OLS and because of the OLS location and proximity to the Containment, Auxiliary Building, Essential Raw Cooling Water (ERCW) piping, Refueling Water Storage Tank (RWST), Main Steam (MS) piping, and Feedwater (FW) piping, the OLS was evaluated for those external events that might cause it to collapse when these SSCs are required to be operable.

The OLS meets or exceeds ASME NQA-1 Subpart 2.15 design requirements, and its load charts and operating restrictions consider applicable dead, live, wind, impact, and out-of-plumb lift loads. The OLS, supplied with standard load charts for its various boom configurations, has a rated load capacity certified by the manufacturer and has been load tested during its production; this meets the load test requirements of ASME NQA-1, 1997 Edition, Subpart 2.15, Section 601.2. In addition, after the OLS has been erected it will be load tested by lifting a 275 ton (550 kip) test load assembly with the OLS boomed out to a radius where the test load represents 110% of the OLS rated capacity at this radius.

The OLS attachments and rigging meet the requirements of ASME NQA-1-1997, Subpart 2.15 and the applicable ASME B30 series standards. The attachments and rigging used to attach the OLS to the SGs have been previously load tested in accordance ASME NQA-1, Subpart 2.15 or have a previous load history that exceeds the loads to be lifted. Rigging will be inspected prior to use in accordance with approved procedures and rigging operations will be controlled and conducted by highly trained and qualified personnel in accordance with approved procedures.

Personnel involved in operating the OLS will receive the following instruction:

- Operators will receive the applicable Sequoyah site-specific training specified in Appendix C of MMDP-2, “Safe Practices for Overhead Handling Equipment” (Reference 9).
- Personnel will undergo hands on training with the equipment before a load is attached to the equipment.
- Prior to a lift, detailed pre-lift meetings will be conducted.
- Direction to the operators during each OLS lift will be given by technical representatives of the equipment owner and the SGR contractor rigging specialist.

During the lifting operation, the exact location of boom tip and load block will be monitored by two independent methods. Instrumentation internal to the crane provides continuous readout of crane and boom orientation and the location of the boom tip and load block. In addition, the boom tip will be continuously monitored from a remote survey station independent from the crane instrumentation. This survey station will have the necessary data input to monitor and calculate the boom tip location relative to the interfacing structures and components. The individual directing the rigging operations will be in constant communication with both the crane operator and the surveyor manning the remote survey station. These controls will be utilized to ensure that the exact location of the load is known and compliance with design requirements are maintained.

Assembly and disassembly of the OLS will be performed in accordance with the crane manufacturer's procedures and drawings and may be performed with Unit 1 and Unit 2 in Modes 1-6 or defueled. The assembly/disassembly process will require the use of mobile cranes and other equipment. During assembly and disassembly of the OLS, the main boom will lay in an area to the north of the Unit 1 Containment. The orientation of the main boom during assembly/disassembly along with restrictions on mobile crane usage and SSC protection provisions ensure that Unit 1 and Unit 2 can be safely shut down and/or maintained in a safe condition in the unlikely event of a load drop during assembly/disassembly of the OLS.

The OLS has been evaluated for seismic loads while unloaded and while loaded with a steam generator (SG). A SG is the heaviest load that will be handled by the OLS. This seismic evaluation determined that the OLS would not collapse or result in a drop of the load during a seismic design basis Safe Shutdown Earthquake (SSE) event for the lift configurations to be used during the Sequoyah Unit 1 SGR. Therefore, use of the crane for the Sequoyah Unit 1 SGR will not result in Seismic II/I interaction issues on the SSCs located in the vicinity of the OLS.

To further demonstrate the capability of the OLS, it was determined that a whip-lash effect resulting from a postulated drop of a load from the OLS will not cause instability of the boom masts in the reverse direction, i.e. the masts will not flip over backwards and impact SSCs (e.g., Auxiliary Building, Control Building, etc.) behind the OLS.

Rigging operations will not be performed when wind speeds exceed the maximum operating wind speed for the OLS. If wind speeds increase during a rigging operation such that the wind speed may exceed the maximum operating speed, rigging operations will be suspended and the unloaded OLS will be secured by implementing administrative controls specified by the manufacturer. These administrative controls define the allowable mainmast and jib angles, and the slew drive and load block configurations, and are dependent on the wind speed.

To eliminate the effects of wind conditions beyond the maximum operating wind speed, a lift will not commence if analysis of weather data for the expected duration of the lift indicates the potential for wind conditions in excess of the maximum operating wind speed. Further, should there be an unexpected detrimental change in weather while the OLS is loaded, the lift will be completed and the OLS will be placed in its optimum safe configuration or the load will be grounded and the crane will be placed in a safe configuration.

The acceptability of the offsite dose consequences associated with a postulated drop of an OSG has been evaluated and compared to the consequences of postulated design basis accidents for a gaseous release. The evaluated consequences of an OSG drop are within the applicable regulatory requirements and are much less than the limiting licensing design basis accidents currently evaluated in Chapter 15 of the UFSAR.

Section 5.1.5 of NUREG-0612 indicates that the effects of load drops should be analyzed (in accordance with the guidelines of Appendix A to NUREG-0612) and the results should indicate that damage to safe shutdown equipment is not sufficient to preclude safe shutdown. Each of the potentially affected SSCs has been analyzed in accordance with the NUREG-0612 guidance to determine the effects of a load drop. Summarized below is the protection required to preclude an adverse effect and/or the actions or compensatory measures required to mitigate these effects should a load drop occur. Provision of the identified protection and implementation of the specified actions and compensatory measures assures that safe shutdown can be achieved following a load drop.

- Containment

The heavy loads of concern that will be handled above the Containment will only be moved while the Unit 1 reactor is defueled. With fuel removed from the Containment, the only other safety issue is whether a load drop into the Unit 1 Containment will affect systems common to both units that pass through the Unit 1 Containment. To preclude a SG drop inside the Unit 1 Containment from affecting Unit 2, the ERCW system and Component Cooling System (CCS) shall either be isolated or be capable of being isolated with valves located outside of Containment. In addition, the Spent Fuel Pit (SFP) shall be isolated from the Unit 1 containment.

- Auxiliary Building

Heavy loads will not be handled over the Auxiliary Building and will not roll off the Containment roof onto the Auxiliary Building. Therefore, no additional load drop protection of the Auxiliary Building roof is required.

To preclude flooding of the Auxiliary Building due to a heavy load drop that causes a failure of piping (i.e., ERCW, RWST, PWST, and fire protection piping) in the ERCW pipe tunnel, a wall will be installed in the tunnel near the Auxiliary Building interface. The wall has been designed for 1) the hydrostatic head generated if the tunnel was completely filled with water and 2) an impact load associated with the rushing water just after a pipe break. It will also meet Sequoyah Seismic I (L) requirements, so that an earthquake would not cause a failure of nearby safety-related SSCs as a result of a seismically-induced failure of the wall. Installation of this wall will be completed prior to movement of heavy loads that could cause a failure of the piping and tanks that penetrate the ERCW pipe tunnel.

- Essential Raw Cooling Water System

<u>Unit 1 ERCW Supply Piping and Train A Discharge Piping</u>

Section 9.2.2 of the UFSAR indicates that the ERCW system design function is to supply cooling water to various heat loads in both the primary and secondary portions of each unit. The Unit 1 ERCW system piping near the Unit 1 Containment would likely fail (i.e., crimp or rupture) as a result of the postulated load drops.

The postulated heavy load drop from the OLS might result in the failure of the Unit 1 ERCW trains A and B supply and/or ERCW train A discharge piping for both units. Mitigation of this assumed ERCW piping failure following a postulated heavy load drop requires that compensatory measures be implemented to isolate the affected Unit 1 ERCW piping and restore ERCW flow to required equipment, as necessary. These compensatory measures will be proceduralized prior to use of the OLS for load handling. Personnel will be trained to implement the compensatory measures.

Unit 2 ERCW Supply Piping

The Unit 2 ERCW pipes running parallel to the west side of the Solar Building and east of the Unit 1 Containment do not directly lie on the load path and are located approximately 128 ft. from the load path. They were evaluated for the effects of impact energy due to a postulated drop of the SG at a distance away. This evaluation concluded that the Unit 2 ERCW piping will not fail and will remain functional under the impact effects of the postulated SG drop at a distance away from the piping.

ERCW Ductbanks

The load path for the SGs crosses over two buried ERCW ductbanks. The ductbanks contain cables associated with ERCW trains A and B for both units. Therefore, it is vital that a SG drop does not affect the functioning of these cables. These ductbanks have been evaluated for impact loading from a direct vertical drop of the SG as well as from the subsequent flopover fall of the SG. In order to minimize the impact energy from a vertical drop of the SG, the bottom of the SGs will be carried at an elevation not to exceed 3 ft. above grade while traversing the load path at and near these ductbanks. The impact energy from the flopover fall was determined to be more critical than from a direct vertical drop of 3 ft. The evaluation of the flopover fall of a SG concluded that the ERCW ductbanks will remain adequate in the event of an SG drop if sufficient soil cover is available over the ductbanks. Therefore, additional soil fill protection will be provided in the potentially affected areas above the ductbanks where the grade elevation is lower so as to bring the grade to a sufficient height to protect the ductbanks.

- Refueling Water Storage Tank

No heavy loads will be carried over the RWST by the OLS. Since a potential load drop from the OLS could only occur when Unit 1 is defueled, loss of the RWST function has no safety impact.

- Primary Water Storage Tank

Heavy loads may be carried over the PWST by the OLS. Since a potential load drop from the OLS could only occur when Unit 1 is defueled, loss of the PWST function has no safety impact.

- Main Steam Piping

The MS piping outside the Shield Building is a potentially affected SSC for the postulated load drops. Since a heavy load drop induced failure of the MS piping will be isolated by closure of the MSIVs, no protective measures are required.

- Feedwater Piping

The FW piping outside the Shield Building is a potentially affected SSC for the postulated load drops. Since a heavy load drop induced failure of the FW piping will be isolated by closure of the FW isolation valves, no protective measures are required.

- Fire Protection System Piping

The high-pressure fire pump and flood mode pump piping in the pipe tunnel is a potentially affected SSC for the postulated load drops. To minimize the impact of a rupture of this piping on flooding of the pipe tunnel, valves will be closed prior to movement of heavy loads with the OLS. Closure of these valves minimizes the actions that need to be taken to isolate a break. Closing these valves will not affect plant operation.

IV. NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

TVA has concluded that operation of SQN Unit 2, in accordance with the proposed modification to Technical Specification 3/4.7.4 and implementation of compensatory measures following a load drop from the OLS during the Unit 1 steam generator replacement, does not involve a significant hazards consideration. TVA's conclusion is based on its evaluation, in accordance with 10 CFR 50.91(a)(1), of the three standards set forth in 10 CFR 50.92(c).

A. <u>The proposed amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.</u>

No changes in event classification as discussed in UFSAR Chapter 15 will occur due to the modification to Technical Specification 3/4.7.4 and implementation of compensatory measures following a load drop from the OLS during the Unit 1 steam generator replacement.

Accidents previously evaluated that are relevant to this determination are related to plant external events and load handling. The probability of an occurrence of a seismic event is determined by regional geologic conditions. Weather related events are determined by regional meteorological conditions.

The consequences of an earthquake have not changed. A seismic evaluation has determined that the OLS would not collapse or result in a drop of the load during a seismic design basis SSE event for the lift configurations to be used during the Sequoyah Unit 1 SGR. Therefore, use of the OLS for the Sequoyah Unit 1 SGR will not result in Seismic II/I interaction issues on the SSCs located in the vicinity of the OLS.

The consequences of a tornado have not changed. A lift will not commence if analysis of weather data for the expected duration of the lift indicates the potential for wind conditions in excess of the maximum operating wind speed. Rigging operations will not be performed when wind speeds exceed the maximum operating wind speed for the OLS. If wind speeds increase during a rigging operation such that the wind speed may exceed the maximum operating speed, rigging operations will be suspended and the unloaded OLS will be secured by implementing administrative controls specified by the manufacturer. Further, should there be an unexpected detrimental change in weather while the OLS is loaded, the lift will be completed and the OLS will be placed in its optimum safe configuration or the load will be grounded and the crane will be placed in a safe configuration.

An OSG drop has been postulated to occur to address the radiological consequences associated with the drop. The event is bounded by the OSG drop outside the containment (versus inside containment), since a steam generator failure outside containment results in more conservative doses. The dose analysis demonstrated that the OSG drop accident consequences remain below applicable regulatory limits and are bounded by similar previously evaluated accidents at Sequoyah.

Therefore, the proposed modification to Technical Specification 3/4.7.4 and implementation of compensatory measures following a load drop from the OLS during the Unit 1 steam generator replacement will not significantly increase the probability or consequences of an accident previously evaluated.

B. <u>The proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.</u>

The possibility of a new or different accident situation occurring as a result of this condition is not created.

Three postulated scenarios related to heavy load handling during the SGRO were examined for their potential to represent a new or different kind of accident from those previously evaluated: 1) a breach of an OSG, resulting in the release of contained radioactive material, 2) flooding in the Auxiliary Building caused by the failure of piping in the ERCW tunnel, and 3) loss of ERCW to support safe shutdown in the operating Unit.

Failure of an OSG that results in a breach of the primary side of the steam generator could potentially result in a release of a contained source outside containment. The consequences of this event, both offsite and in the control room, were examined and were found to be within the consequences of the failure of other contained sources outside containment at the Sequoyah site.

To preclude flooding of the Auxiliary Building due to a heavy load drop, a wall will be installed in the ERCW tunnel near the Auxiliary Building interface. Thus, the postulated flooding of the ERCW tunnel will not result in flooding of the Auxiliary Building beyond those events previously evaluated.

The potential for a heavy load drop to cause loss of ERCW supply to Unit 2 is considered an unlikely accident for the following reasons:

- The lifting equipment was specifically chosen for the subject heavy lifts,
- Operators will be specially trained in the operation of the equipment and in the Sequoyah site conditions,
- Qualifying analyses and administrative controls will be used to protect the lifts from the effects of external events,
- The areas over which a load drop could cause loss of ERCW are a small part of the total travel path of the loads.

However, as additional protection against the potential for loss of ERCW, compensatory measures will be in-place during heavy lifts that could cause such a loss to isolate the breaks and redirect flow to essential equipment.

Therefore, the potential for creating a new or unanalyzed condition is not created.

C. The proposed amendment does not involve a significant reduction in a margin of safety.

The OLS load handling activities support the replacement of the Unit 1 steam generators. The proposed change to the Unit 2 TSs and compensatory measures support Unit 2 operation and safe shutdown following a load drop. They do not result in changes in the design basis for plant SSCs. They do not, therefore, affect the margin of safety for plant SSCs.

Therefore, a significant reduction in the margin to safety is not created by this modification.

V. ENVIRONMENTAL IMPACT CONSIDERATION

The proposed change does not involve a significant hazards consideration, a significant change in the types of or significant increase in the amounts of effluents that may be released offsite, or a significant increase in individual or cumulative occupational radiation exposure. Therefore, the proposed change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed change is not required.